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OCT 7 - 1935

Heating · Piping and Air Conditioning

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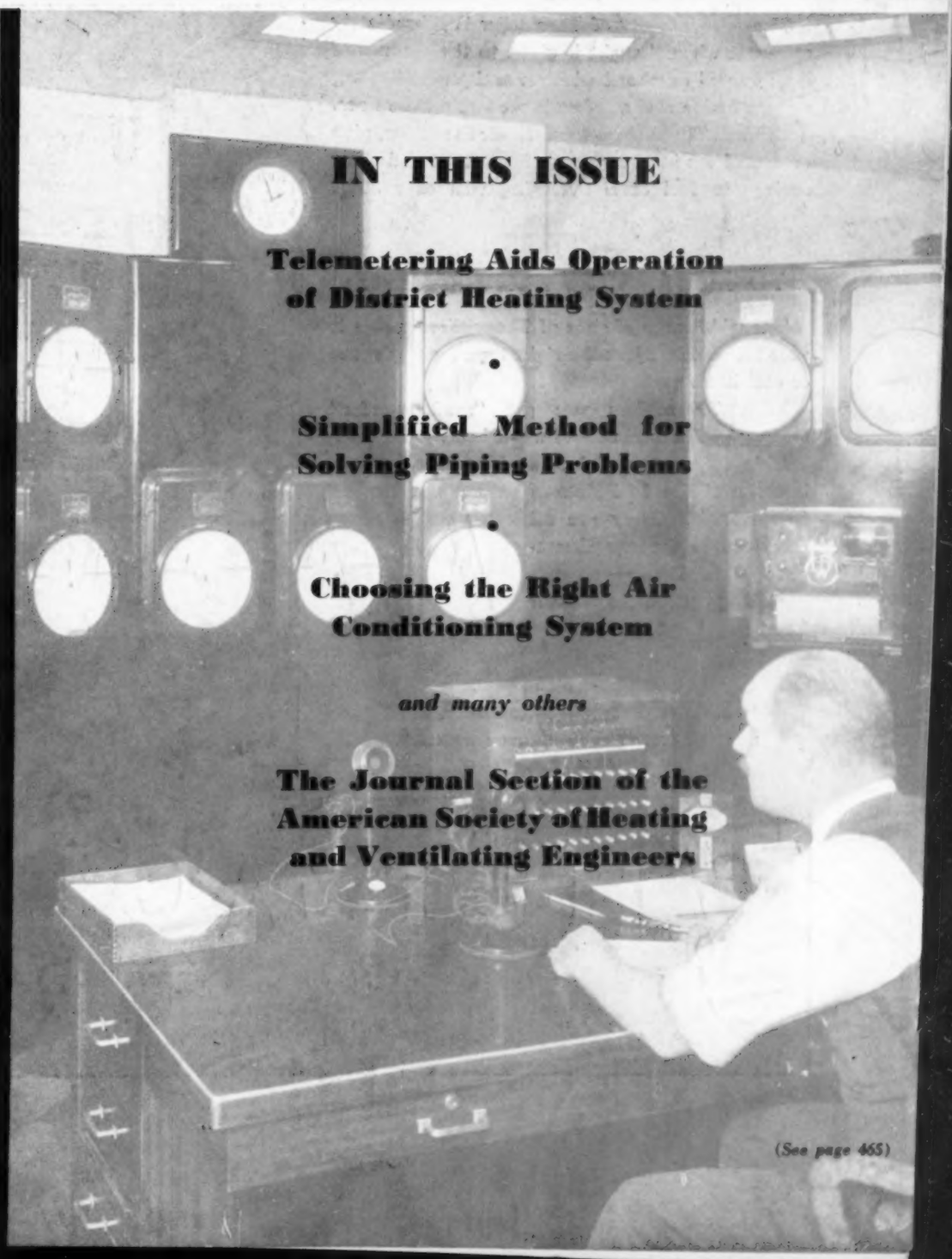
INDUSTRY AND
RGE BUILDINGS



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Telemetering Aids Operation of District Heating System

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Simplified Method for Solving Piping Problems

•

Choosing the Right Air Conditioning System

and many others

The Journal Section of the American Society of Heating and Ventilating Engineers

(See page 465)

October, 1935

Warm air like oil stays on top.

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THE GRINNELL UNIT HEATER WITH 14 POINTS OF SUPERIORITY

THE EDITOR'S PAGE

● "Loans up to $50,000" is the title of the latest Federal Housing Administration booklet; copies may be had direct from FHA headquarters, or The Editor will be glad to forward readers' requests. . . . Aim of the booklet is to explain how modernization credit for business property improvement or re-equipment offers a means whereby business and industry may protect itself against the costly results of obsolescence, keep in step with modern production methods and equipment, and modern organization for profit. . . . Pointing out that profit is the real reason for business property modernization, various types of buildings are discussed and illustrated, the modernization credit plan is described in question and answer form. . . . Sound engineering is stressed as not only desirable but necessary, and retaining a consulting engineer on plant modernization work is advised.

● There are 2,525,573 buildings in the U. S. that the amended National Housing Act makes eligible for modernization loans up to $50,000, estimates Major R. B. Lawrence of the FHA, and which open up a large field for the heating, piping and air conditioning industry. The total comprises 643,779 apartment buildings; 29,462 hotels; 1,526,119 retail establishments; 164,170 wholesale establishments; 141,776 manufacturing plants; and 20,267 colleges, schools, orphanages, etc.

● Largest activity for any week since the beginning of the program was recorded by the FHA for the week ending September 21, with $14,420,375 worth of business being reported under *both* the modernization credit plan and mutual mortgage insurance plans. . . . Following are the monthly totals for modernization and repair notes insured (Title I) *only* since August, 1934, and through September 21, as released by Stewart McDonald, Administrator:

August, 1934	$ 251,595
September	3,274,425
October	8,834,565
November	9,852,992
December	8,237,006
January, 1935	6,582,034
February	5,269,524
March	7,814,722
April	11,300,416
May	14,415,746
June	16,154,052
July	21,084,565
August	24,240,035
September (21 days)	21,973,996

● The bee was the original air conditioning engineer, according to Malcolm McDowell in the Chicago *Daily News* last month. . . . Thousands of them line up at the entrance of the hive, fanning their wings to circulate air through the hive, which lowers the 60 to 80 per cent water content of the nectar to less than 20 per cent after it has ripened into honey. . . . Several companies are adding "nose appeal" to their products, according to *Nation's Business*. Among them is a pine-scented coal, reputed to act as a "cold preventive." . . . Increased use of air conditioning will soon over-tax the nation's water supply, predicted A. R. McGonegal, chief plumbing inspector of Washington, recently, and water supply systems will have to be remodeled to meet the increased demand in three to five years. An article by Rudolf Kuhlmann published in H. P. & A. C. earlier this year described how South American air conditioning engineers conserve water, predicted that more attention would soon be given this phase in the U. S.

● Air conditioning has made rapid progress in Argentina, particularly in Buenos Aires, reports Assistant Trade Commissioner D. G. Clark to the Department of Commerce; a bright future is anticipated, as the summers are hot and humid.

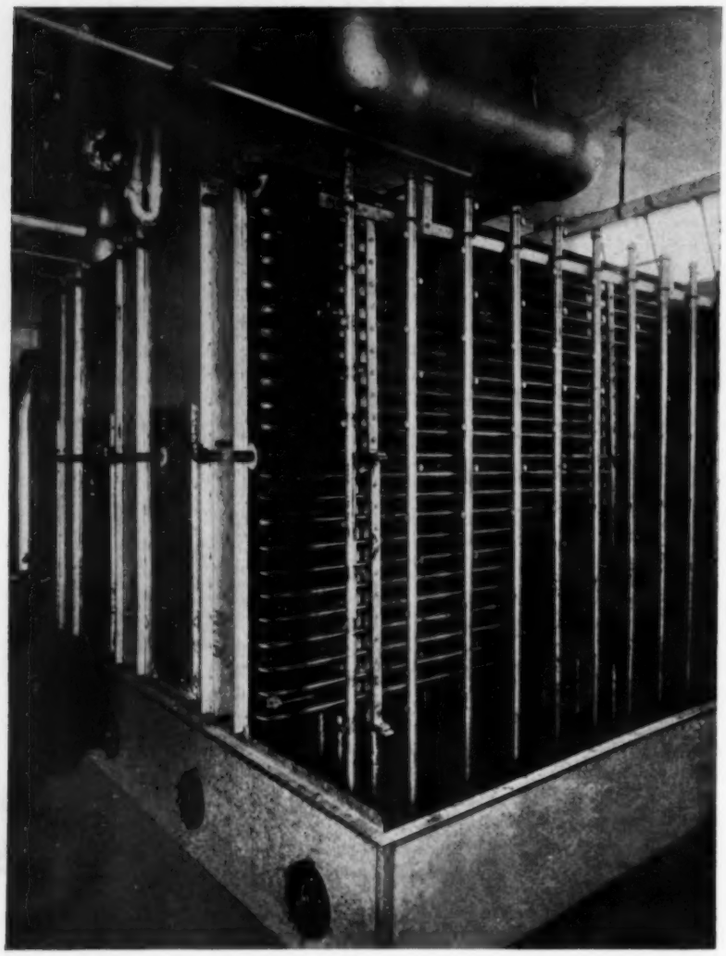
● The plan of reorganization to effectuate the union of the business of the Inland Steel Co. with that of Joseph T. Ryerson & Son, Inc., was approved at a special stockholders meeting on September 20. . . . Republic Steel Corp. was awarded first prize for the most outstanding advertising campaign of the year in the field of metals by the judges at the annual conference of the National Industrial Advertisers Association at Pittsburgh last month.

● So popular has been the course in air conditioning at the New York Y. M. C. A. schools that a third course will be given starting Monday evening, October 7, 8 p. m. Object is to qualify students for positions as maintenance men, installers and salesmen. William Hull Stangle is the instructor. . . . A two term course in community planning at the New York University school of architecture and allied arts was announced last month; first term began September 24, and the second term begins February 5. Dr. Carol Aronovici is in charge, and is to be assisted by a number of specialists in particular phases of the subject. . . . Eighteen colleges and universities in the New England and Middle Atlantic States offering courses leading to an engineering degree have requested the Engineers' Council for Professional Development to consider their curricula for accrediting under the plan announced last June.

● Sales of Class 1, 2, and 3 stokers for the first six months of 1935 were 73 per cent greater than for the same period in 1934, biggest year in the history of the stoker industry, according to the Committee of Ten of the Coal and Heating Industries. . . . Capacities of these three classes are less than 100 lb of coal per hour, 100 to 200 lb, and 200 to 300 lb, respectively. . . . At the annual meeting of the Steel Heating Boiler Institute at Buffalo last month, J. T. Dillon Jr. was elected president, Homer Addams and W. R. Meikle were elected vice presidents, and R. A. Locke was named secretary and treasurer. . . . Formation of "Oil and Allied Industries, Inc." for the codification, clarification, and coordination of all rules, laws, regulations and ordinances affecting the installation of oil burning equipment was announced in a release last month from Irving A. Heimlich, secretary, 1440 Broadway, New York City. . . . The annual meeting of the Refrigerating Machinery Association will convene at the Palmer House, Chicago, on Friday, October 11, and will be marked by the initiation of a broad equipment standardization program recommended by the Association's executive and standards committees, according to President D. Norris Benedict. . . . The building code committee of the American Standards Association met last month to organize, will continue the development of standards applicable to building codes started in 1921 by the Department of Commerce committee and discontinued early in 1934.

● Work is well under way on HEATING, PIPING AND AIR CONDITIONING'S January issue, planned to be the most outstanding ever published. . . . A complete directory of heating, piping and air conditioning equipment for industrial and large buildings and a special section devoted to the fourth International Heating, Ventilating, Air Conditioning Exposition (to be held Jan. 27 to 31) will be included in addition to outstanding articles on heating, piping and air conditioning subjects and the Journal Section of the American Society of Heating and Ventilating Engineers.

Based on past performance
TONCAN IRON
is again specified for Air Washer



Five years ago, a large drug manufacturer installed an ammonia evaporator in an air washer. The material selected for both pipe and sheets was Toncan Iron. Recently, a similar installation was needed in the same plant. The performance of Toncan Iron during the last five years caused it to be specified for the new unit.

Service conditions such as are encountered in an installation of this sort are severe—air and moisture combine forces to tear down the ferrous structure. But Toncan Iron is not an ordinary metal. Refined open hearth iron, copper and molybdenum are here combined to form an alloy that possesses the highest rust-resistance of any ferrous metal in its price class. It often takes years for users to find out how superior Toncan Iron really is—how much more economical it is in service.

You'll find the story of Toncan Iron in "The Path to Permanence," if you're interested in sheets, and in "Pipe for Permanence," if pipe troubles worry you. Either, or both books, sent on request.

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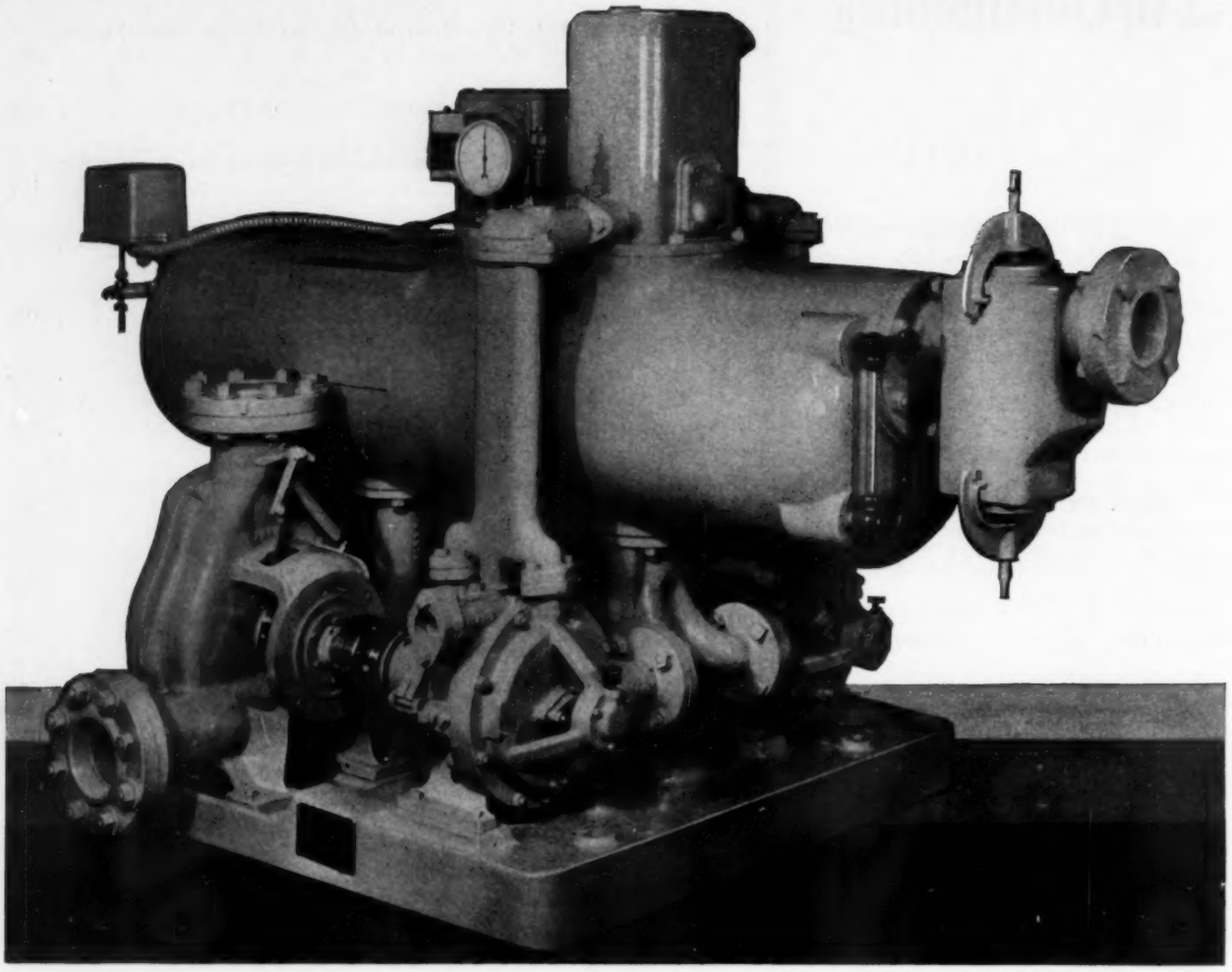
YOU CAN CUT YOUR HEATING COST WITH THIS NEW NASH STEAM OPERATED PUMP.



This remarkable Return Line Heating Pump requires no electric current, eliminating the greatest expense item in the operation of any ordinary pump. The motive power is a special turbine. It operates on any heating system, above or below atmosphere.

The steam which operates the turbine passes directly back to the heating mains with little heat loss. None is wasted.

But the really important saving effected by the Vapor-Turbine is in the system, for the reason that this pump operates continuously. It is the only pump that can do this with economy. Continuous operation means uniform circulation, and uniform circulation saves steam. Owners report remarkable savings in fuel with the Vapor-Turbine.

Mechanically, this pump is a marvel. One moving element, no wearing parts, no interior lubrication. Compact, trouble-proof.

NASH ENGINEERING COMPANY
SOUTH NORWALK, CONNECTICUT, U. S. A.

Heating · Piping
and Air Conditioning

Vol. 7, No. 10. • *October, 1935*

Telemetering Aids Operation *of* District Steam Distribution System

By **T. E. Purcell***

GOOD service—an asset in any business—is more than that in district steam heating; it is of prime importance. To create and hold a business which so intimately affects the convenience, comfort, and welfare of the public, and which is so vital for the maintenance of the buildings heated thereby, demands that the service be of the highest order. Failures, even for short periods of time, will not be tolerated by the user.

The Allegheny County Steam Heating Company many years ago recognized the necessity for good service and has been making every endeavor to maintain at the highest degree economically possible that which it renders. The latest improvement has been the establishment of permanent headquarters for its system operators, and the installation of long distance recording and indicating instruments as an aid to the maintenance of predetermined conditions throughout the distribution system.

The position of system operator was established in 1927 and a single operator was employed. More operators were added within a few years and the scope of the work extended to include operation 24 hours a day, correlating all plant operations, distribution, customer's service and metering, and receiving and dispatching all customer's service calls. From the beginning the telephone was the instrument that made this centralized operation possible, but in order to prevent the routine of telephoning from becoming burdensome, and to eliminate the necessity of several isolated attendants handling relatively unimportant operations, it was found desirable to install additional instruments which would transmit some information direct.

In this installation, as in many others of recent years, measurements of time have been employed as measurements of displacement, since the displacements actuated by the chronometer itself are all performed at uniform speeds. If railway trains, for instance, ran at uniform speeds of sixty miles per hour, it would be quite as exact to state distances between stations in units of time as in units of linear measurement; this is exactly what is done in this form of telemetering. An oscillating element operated at a uniform speed by a synchronous motor at the transmitter makes and breaks an electric telemetering circuit at time intervals proportional to the displacements to be transmitted. The intermittent electric current thus transmitted operates a pair of electric clutches in the receiving instrument which also revolve at uniform speeds but in opposite directions by means of a local synchronous motor. The motion of these clutches through a limited arc is transmitted to the recording and indicating elements of the meter to reproduce in graphic form the true displacement within the transmitter.

It is significant that in this form of telemetering variations in strength of the transmitting electric current do not affect the accuracy of metering, since its only function is one of timing, and this is done by making use of relatively low voltage telephone circuits.

The System and Its Operation

The district heating system controlled by this equipment consists of two modern plants having a combined capacity of about 1,200,000 lb per hr of steam, together with a smaller plant held in reserve. The Stanwix base load plant consists of two 300,000 lb per hr boilers, fired with pulverized fuel and operating at 200 lb. Steam at this plant is passed through a 5,000 kw non-condensing turbine, and delivered to the low pressure distribution system at about 15 lb. Considerable steam is also delivered at 135 lb to serve customers requiring higher pressure. The other active plant (at 12th and Etna Streets) is operated only during the winter season, delivering its entire output to the distribution system at boiler pressure, where it is passed through pressure reducing valves and distributed at 125 lb.

The distribution area, Fig. 3, comprises about one square mile and serves 242 customers. Practically all of the office buildings and the department stores in the downtown area are served, including all of the large office buildings erected within the last ten years. One of the distinctive features of this system is the return of about 80 per cent of the condensate through pipe

*General Superintendent, Allegheny County Steam Heating Co., Pittsburgh, Pa.

lines paralleling the main steam lines. In many cases these return lines are in accessible tunnels, and valves are provided by means of which condensate can be diverted to either of the main plants. As the plants are on the river front at lower elevations than a majority of the customers served, condensate is returned by gravity; the larger customers having deep basements lift their condensate to the company's lines by means of pumps.

The system operators specify the most economical loading of boilers, byproduct turbo-generators and plant auxiliaries in routine operation, and issue permits for the performance of all major operating and maintenance work depending upon system conditions. Both main plants are operated in parallel, and the regulation of steam pressure during the winter season requires considerable attention on the part of the system operators.

It is important that all pressures be maintained reasonably constant in the uptown section at a distance of approximately ¾ mile from each of the main plants; in order to accomplish this, 14 long distance recorders were installed at points as indicated on Fig. 3. The operating conditions transmitted are:

12th Street Plant

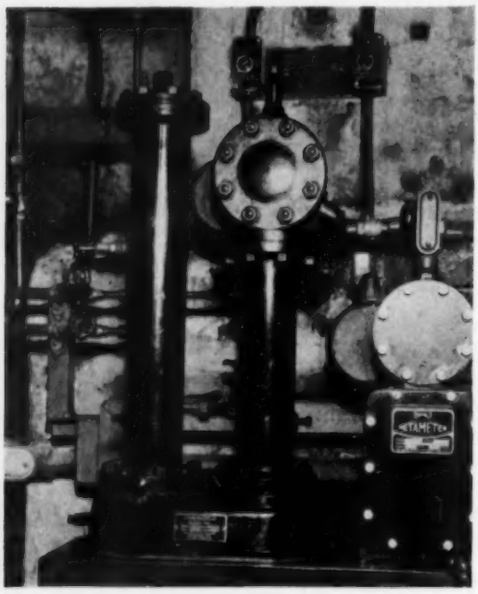
1—Steam pressure—average 130 lb
2—Rate of condensate flow
3—Temperature of condensate

Central Reducing Station

1—Steam pressure—average 125 lb
2—Steam pressure—average 10 lb

Oliver Reducing Station

1—Steam pressure—average 125 lb
2—Steam pressure—average 12 lb



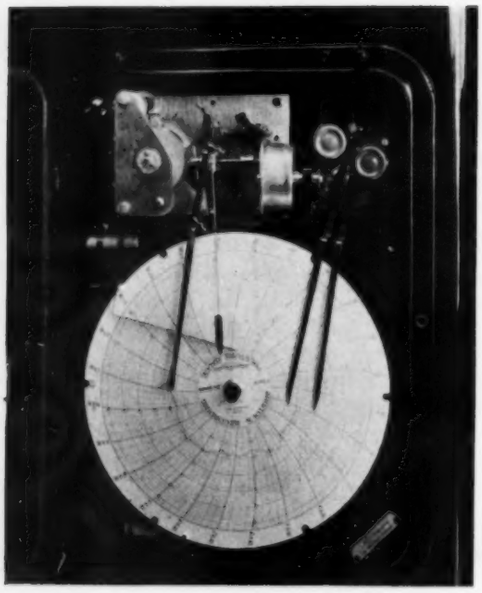
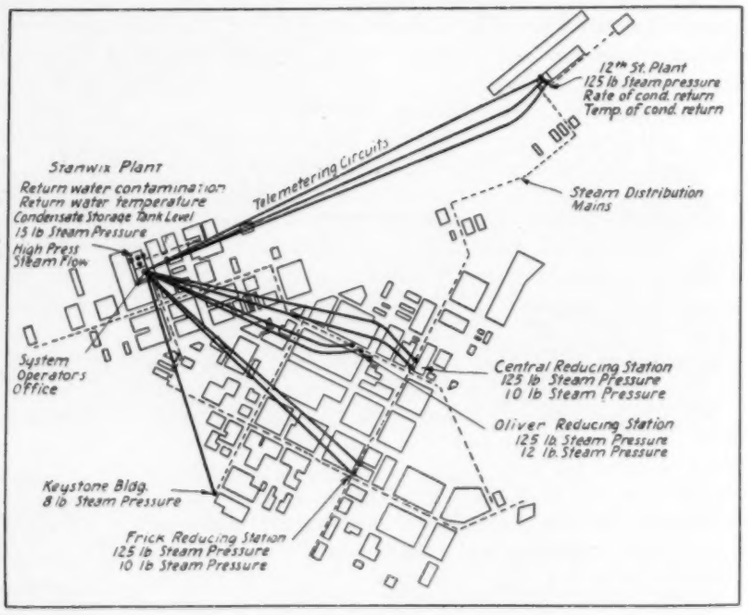


Fig. 1 (*left*)—Transmitters for the long distance recorders, the one on the left for steam flow and that at the right for pressure. Fig. 2 (*left, below*)—Long distance recorder, open, showing operating clutches at top left, motor drive at right center, and high and low alarm attachment to the right

Fig. 3—(*below*)—Downtown Pittsburgh distribution area, showing points from which system conditions are transmitted by telemetering to the system operator's office, Fig. 4—(*opposite*), located near the Stanwix plant; the multi-point recorder at the extreme right gives a continuous chart of the contamination of the returning condensate in parts per million as read from electrical conductivity cells inserted in the return lines



Best operation of many piping systems, industrial processes and heating and air conditioning systems requires the transmission of information on flow, pressures, temperatures, liquid levels or other factors to a central point..... The Allegheny County Steam Heating Company recently installed the telemetering system described here to improve operation of its steam distribution system, render a better service to its customers.....Features of this modern aid to control are explained; other applications will suggest themselves to the reader

Frick Reducing Station
1—Steam pressure—average 125 lb
2—Steam pressure—average 10 lb
Keystone Hotel Building
1—Steam pressure—average 8 lb
Stanwix Heating Plant
1—Contamination of condensate
2—Temperature of condensate
3—Water level in condensate storage tank
4—Steam pressure—average 135 lb
5—Steam pressure—average 15 lb
System Operator's Office
1—Outside temperature.

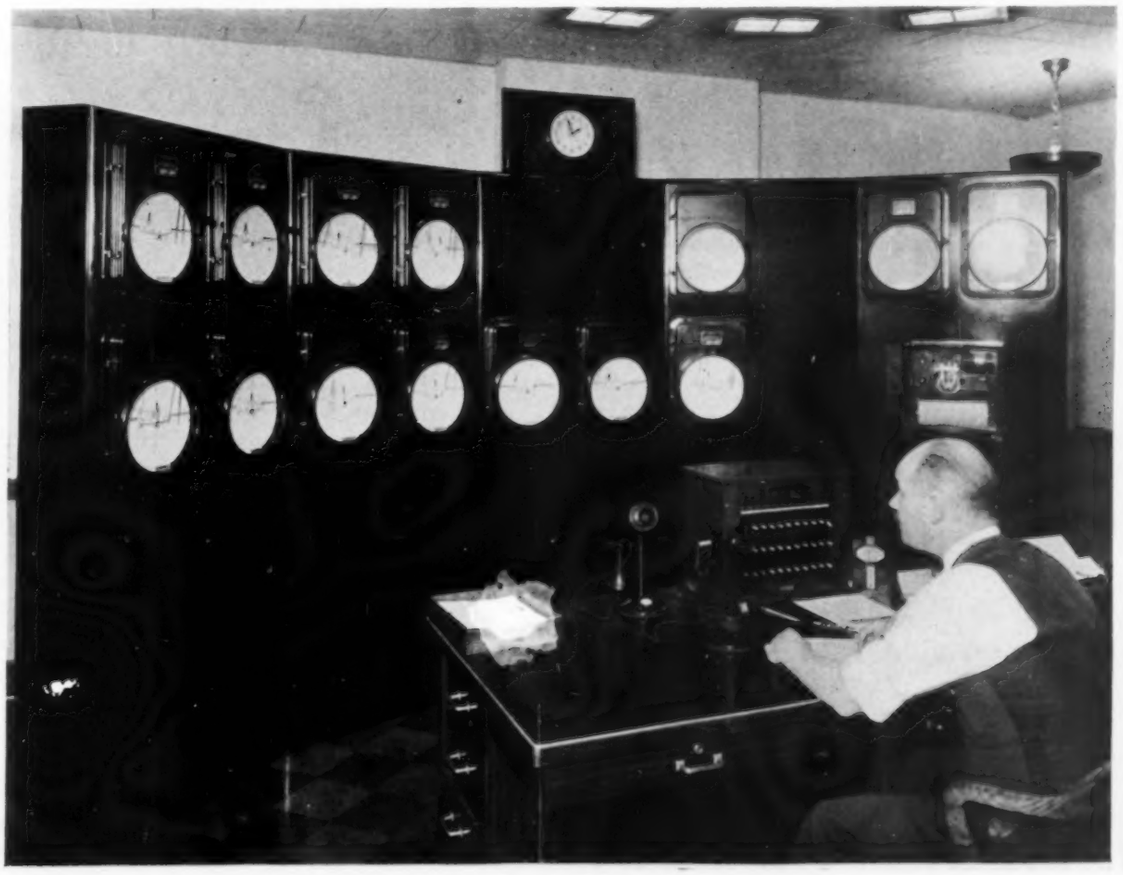
The Telemetering Equipment

A typical form of the transmitter is illustrated in Fig. 1; a transmitter for steam flow in a 12 in. high pressure main is shown on the left, and the transmitter for static pressure on the right. Fig. 2 is an open view of the recorder. The working parts include the magnetic clutches (top left of view) which are revolved at uniform speeds in opposite directions by the synchronous motor, right center. One clutch moves the recording pin from zero to the operating position, and the other from maximum deflection to the operating position, these motions alternating at 15 sec intervals so as to trace a sensitive record of any mechanical displacement in the transmitter. The various transmitters are of course actuated in the same way by either pressure, rate of flow, temperature, liquid level, etc. The high and low alarm attachment is shown on the right hand side of the recorder.

The general arrangement of the instruments in the system operator's office is shown in Fig. 4. It will be seen that the instruments are arranged in semi-circular form in front of the operator at a convenient height, and sufficiently close to enable him to distinguish the trend of the graph on each recorder. An indicator on each instrument shows variations from the normal operating position, and a graphic record of the same movement is traced on the chart. High and low pressure alarms are provided on the more important recorders, which operate both an audible and visible signal in case of large irregularities.

It will be noticed that spaces have been left near the center of the board for additional instruments and also for an additional panel on each end. A particularly important instrument is shown on the lower right hand side of the board—a multi-point recorder used to give a continuous record of the contamination of the returning condensate. This instrument is basically a potentiometer type voltmeter recording on a strip chart variations in voltage between two electrodes built into a specially constructed cell. The variations in this voltage are proportional to the conductivity between the electrodes, which in turn is almost truly proportional to the solid contents of the water. The instrument is therefore calibrated directly in parts per million. The contamination of the condensate varies with the load and season of the year, the minimum of about 2 ppm occurring in the spring, and a maximum of about 15 in the fall.

The operation of this device is so sensitive and reliable



that the breaking of a water heater tube, for instance, anywhere on the system, which allows city water to mingle with condensed steam, is identified by a rise in contamination within a very few minutes. The source of the trouble is quickly found by a process of elimination in which the contamination of the water from the various incoming lines is individually measured by means of hand samples.

Other instruments not shown include an observatory type mercurial barometer from which hourly observations are recorded primarily for use in meter testing, and office instruments used in connection with the air conditioning of the premises.

The system operator's office is in a building housing heavy machinery, and in order to minimize the effect of noise and vibration, special precautions were taken to provide insulation and sound-deadening materials on floors, walls and ceilings. Adequate telephone facilities connect the system operators by means of a direct line with all parts of both main plants, service headquarters, and the main office.

The system operators work on 8 hr shifts, receiving and dispatching service calls from customers in addition to their duties of supervising system operation; and are on duty continuously for 10 days, followed by a relief period of 4 days. This gives each operator 80 hours of work in each two weeks' period, or an average of 40 hours per week. Operators change shifts at appropriate intervals in order that all may have an impartial share of duty on Sundays, and to some extent on holidays.

In order to facilitate the transmitting of information from one operator to another at the time of changing shifts, a map board is provided which shows the main line piping and valves with appropriate signals designating the setting of all important valves as to whether or not the conditions are abnormal, and the pressures at which reducing valves are set to operate.

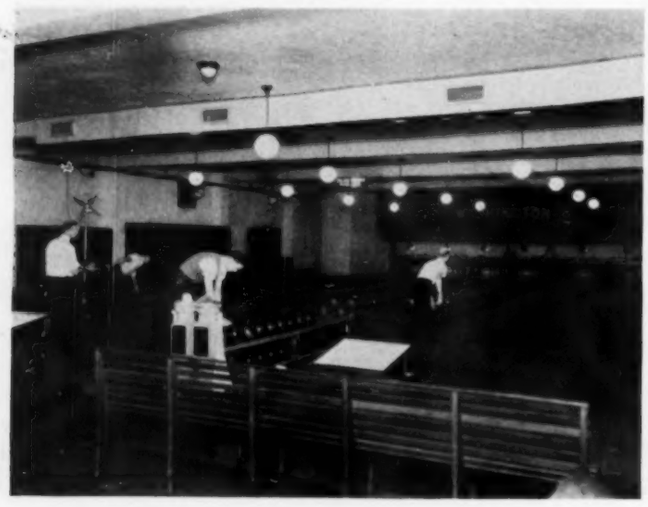
Another contemplated improvement as a companion feature to the long distance recording instruments will consist of the remote operation of valves by the system operator. The principal purpose to be accomplished is the control of the flow of condensate from various branch mains so as to divert it to either generating station as needed or to storage tanks, and the remote setting of reducing valves.

Air Conditioning Makes a "Strike"

—Increases Bowling Alley's Business by Forty Per Cent

By **J. M. Chambliss***

AIR conditioning gets the credit for a 40 per cent increase in business for the Washington Recreation bowling alleys, Newark, N. J. Further improvement is expected as bowling becomes a year around sport, and the summer increase will undoubtedly prove the air conditioning investment to be a paying proposition, as formerly profits have had to depend mainly upon returns during the winter.

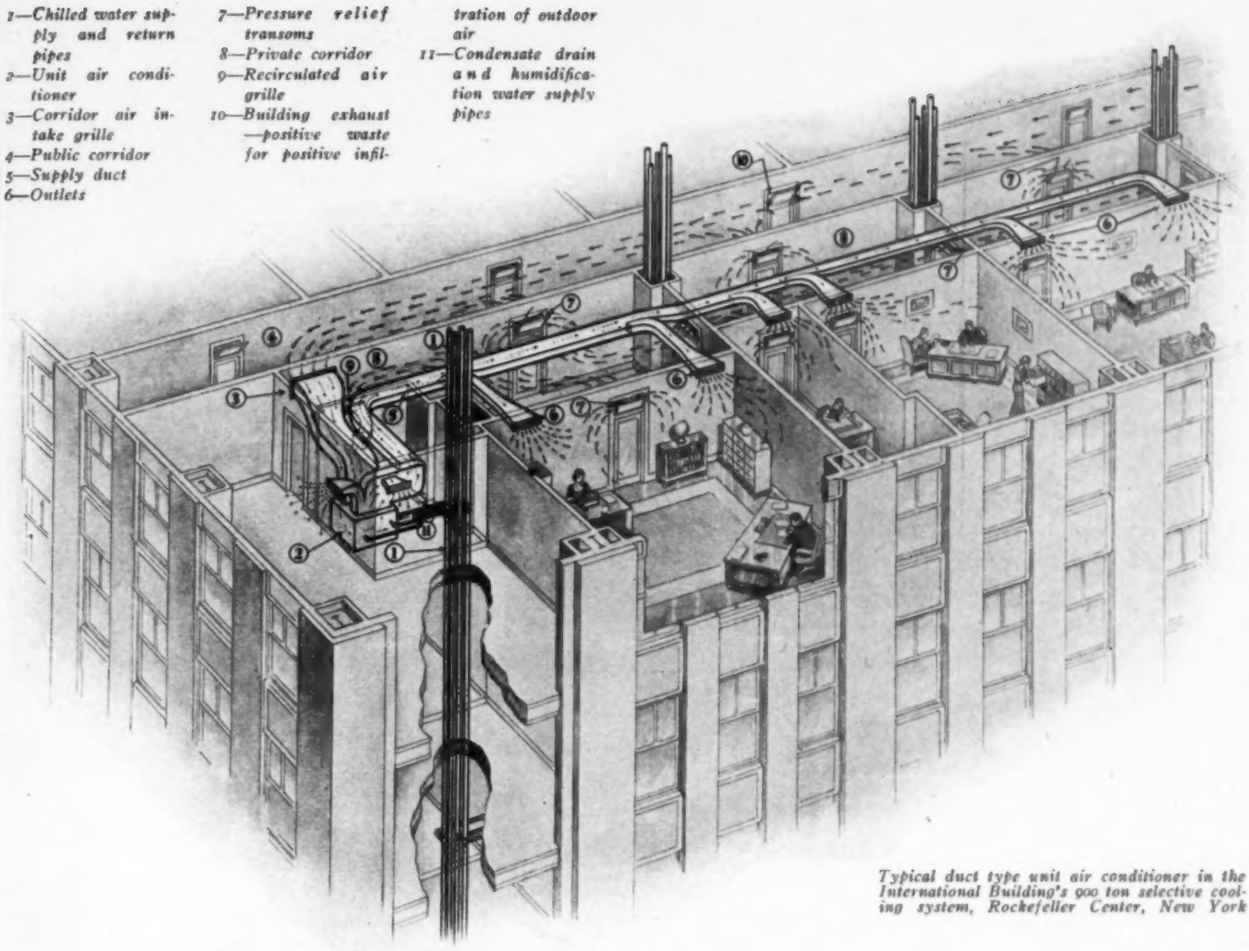


A unique type of "zone cooling" well suited to the application is used; only the section of the space where the bowlers and spectators are located is cooled to about 15 F under the outdoor temperature. Obviously, this is more economical than cooling the entire area.

The compressor unit, driven by a 7½ hp motor, and the air conditioner, with a ¾ hp motor driving the circulating fan, are installed in the basement. The cold air duct is run up and directly across the bowling room, at the ceiling, a few feet away from the player's position. Several outlets are arranged so that the cold air is forced out along the ceiling toward the front of the room, creating a gradual circulation in the space occupied by the players and spectators, without causing a direct draft. The system is arranged so that the desired percentage of outdoor air may be drawn in along with the recirculated air. Smoke and dust are eliminated and the proper relative humidity is maintained.

The installation was designed and installed by the Blocker Air Conditioning Corp. of Newark.

*Century Electric Co., New York, N. Y.



Typical duct type unit air conditioner in the International Building's 900 ton selective cooling system, Rockefeller Center, New York

CHOOSING *the right* AIR CONDITIONING SYSTEM

Part 7—The Use of Units

By - - - - - **A. Warren Canney***

The applications of the unit type of air conditioning system, factors involved in locating the equipment, air supply, control of direct expansion units, and the design of coil type jobs are among the subjects covered this month . . . . . This series (of which this is the seventh part), while addressed primarily to prospective owners of air conditioning systems, has proved popular with other readers as well

THE unit type of air conditioning system is comparable to a steam or hot water heating system, in that it comprises a central apparatus for heat transfer from a fluid medium, a flexible method of distribution which occupies but little space, and standard elements of assorted available capacities for effecting heat transfer from the individual building sections or spaces in accordance with the capacity requirements. Thus, in a sense, unit air conditioning puts this service on a par with straight heating. However, we not only have a heat conveying fluid to deal with, but apparatus which is of a much more dynamic character—comparing refrigeration to the boiler and the fan, drive, electric motor, the forced movement of air and the open collection of condensation to the comparatively static radiator or convector—which complicates the problem.

*Engineer in charge of air conditioning, Clyde R. Place, Consulting Engineer, New York, N. Y., Ernest Williams, Manager.

When to Use Units

There are a considerable number of conditions which may decide in favor of piping the refrigerant or water in place of air, or in indicating the choice of a unit type rather than a central station air conditioning system. These may well be classified as (1) technical and physical considerations, and (2) business considerations. The unit type of job may well be considered, but not necessarily indicated, when one or more of the following conditions are encountered:

Physical and Technical

1. Where large trunk air ducts would be objectionable, which usually obtains in existing structures.
2. Where there is insufficient space for a centralized apparatus or where available areas are too valuable.
3. Where the ground floor space is leased by another tenant ruling supply and return duct shafts out, but where refrigerant or water pipes would be permissible.
4. Where ducts are unnecessary, or where space limitations rule duct work out, or where the use of ducts would be objectionable on architectural grounds.
5. The use of year-round units for radiator replacement.
6. Where the space is divided into many compartments.
7. Where the sound level increase due to the proximity of the equipment would not be objectionable.
8. Where the relative humidity need not be accurately controlled independent of temperature, which is usually the case in comfort systems.
9. Where an adequate outdoor air quantity can be introduced.
10. Where individual temperature control in individual spaces will be required.

Business

1. Where the buyer's lease will expire in less time than the normal life of mechanical equipment, with the prospect of moving possible.
2. Where there is a likelihood of interior or building alterations of such nature as would make alterations of duct work from a central plant objectionably expensive as compared to altering a unit system.
3. Where, due to the character of the space, heat loads may increase at some future time.
4. Where maintenance in the conditioned spaces would not be objectionable.
5. The use of ceiling units where headroom is adequately high.
6. Where an owner wants the public to see the apparatus.
7. The purchase of equipment (without results guarantees) in easier financial stages by adding units in the future.
8. Where the installation and operation of units as leasing progresses in a new structure shows an over-all economy.
9. Where heat loads are not known until the space is leased.
10. Where tenancy is variable, involving potentially different partitioning and heat load requirements.

Location of Equipment

It is important to decide whether the units may be located in the conditioned spaces, particularly if duct work is considered. Duct work is used to secure proper air distribution quite as much as to utilize air as a heat conveying and controlling medium between the apparatus and the spaces conditioned.[1] However, economics may play a dominant role in this decision. For instance, picture the floor plan along the side of a building comprised of ten structural bays, with a partitioned office in each bay. Which would be cheapest, one unit in each office with no duct work except a window outdoor air connection, one unit taking the necessary outdoor air for all the offices from one point and with a single feed duct, or two units with duct work each supplying five offices? While it is possible that one unit would be the cheapest, it is probable that for space reasons, control and appearance two units would be a better solution. With the single or two unit job, the unit or units would likely be located in some space having the least value toward the interior of the building and therefore outside of the conditioned spaces. In this case, a certain amount of duct insulation would help offset the cost of the individual unit job. If, on the other hand, the individual spaces were subjected to periods of non-occupancy whereby the individual units could be shut down at times, an operating saving would help to favor this method. If some of the spaces were angular instead of square or oblong, then duct work for those rooms would be indicated for better air distribution.

It is advisable to keep the units out of the conditioned spaces and toward the interior of the structure or at least to locate them so as to avoid complicated piping on the ceiling of the outside room underneath to preserve architectural neatness and avoid deep reveals at outside columns. In placing units at the windows the drains provide the rub. Vertical lines can be carried down but in tall buildings they must be carried over to the interior at intervals at some level or another and to avoid odor they must be many times larger than for the gravitational drainage size for the water waste requirements involved. Large pipe surface and quick drainage minimizes the backing up of drain pipe odor.

The matter of new air supply is important. Tapping off the old building ventilation system might be satisfactory, or taking air from the corridors while injecting outdoor air into the corridors with a separate fan and duct system may do it. It is also feasible to let some of the units recirculate, with a sufficient number of them taking 100 per cent outdoor air so that the arrangement as a whole will provide proper fresh air dilution. This can only be accomplished well if the air handled by the entire group of units has a common place to pool and mix.

From a designer's standpoint the best arrangement is perhaps to make each unit an individual plant in effect by the provision of positive outdoor air and positive exhaust volumes. Otherwise what precisely will happen in a multi-story building is hard to predict even under specific structural circumstances.

It is important to locate floor type units so that the air stream will first absorb the major source of heat in the room in order to avoid spotty conditions. In general, however, in rooms that are not too large and which have flush ceilings, astute location of the unit with the above in mind together with a "snappy" velocity of impact perpendicular to the ceiling provides very satisfactory air distribution. Then again, ceiling units may be used with high ceilings (as in department stores) which discharge large masses of air on a high temperature spread at high velocity without anything more in the matter of air distribution to be desired. But unless the space is large, permitting a long blow so that this air can "peel off" before it drops to the occupants, the job will be a failure. Ducts and suitable outlets for careful air distribution are a wise investment.

[1] See Heating, Piping and Air Conditioning, April, 1935, pp. 202-204.

The combined design and operating temperature level of ceiling units must be checked to avoid sweating. Piping connections and piping insulation must be watched, particularly when the units are over sales or other public spaces or display goods.

Direct Expansion Units and Control

With a large number of evaporating units involving a complex refrigerant piping system, dissatisfaction may result—especially with individual expansion valves for control at each unit—unless the design allows for whatever frictional unbalancing will obtain under all operating conditions for both the liquid feed and gas suction piping. Care must be taken to prevent the coils from passing slugs of liquid, which differential valves across each coil will materially assist to prevent. Oil collecting pockets are to be definitely avoided. On such a set-up, a split compressor job may enable simplification of refrigerant piping and permit both results and operating costs to reflect differentials in heat loads in the areas served by the various units. With a multiple refrigeration unit installation, automatic sequence control will allow for cutting the compressors in and out better to stabilize delivery air conditions with the load. Refrigerant piping may be arranged parallel to a common feed and common return between the refrigerant headers and the coil. Two other very good variations are (1) individual refrigerant lines from each condensing unit to coil sections in series in the air stream, each section of coil traversing the entire face of the duct and over which the supply fan passes all the air delivered, or (2) a split coil in the face of the air flow, each section connected independently to its own condensing unit which is operated by automatic on-and-off control, and which method involves bypassing when any coil section is in disuse, whereas the first method does not.

There are three main difficulties to be avoided in the use of direct expansion coils, all of which have to do with control, which also means design arrangement *for* proper control. Before discussing these, let us clearly fix in mind just what it is we want to have happen in any air control system involving simultaneous absorption of the heat of gases and vapor content.

We naturally design a system for the combined maximum heat absorption of the gases and the vapor and in any system the ratio of the latent to total heat to be absorbed has some definite value, as has been previously pointed out in this series. This ratio will change under operating conditions, and if we were to employ a spray dehumidifier resulting in a saturated supply, the dew point temperature of the supply would have to be varied from time to time above the minimum temperature. Since the effective refrigeration tonnage of any refrigeration machine decreases with lowering suction temperatures, it is very important to ascertain this minimum operating temperature through the ratio of latent to total heats as a basis for refrigeration selection and performance.

This temperature of saturation is necessarily below the dew point temperature of the air to be maintained in the conditioned space because it must rise with the absorption of vapor, and it bears a definite psychrometric relation and value to the heat ratio with respect to the room conditions. Since most comfort systems are being commercially designed to maintain 80 F dry bulb and 50 per cent relative humidity at the time when the *refrigeration* load is presumed to be maximum, and usually is (but not always is with metallic coils), it is possible to determine the saturated supply temperature which, *with a saturating cooler, must* be delivered to satisfy various ratio values for any room conditions. These values are shown in the following list (for 80 F dry bulb and 50 per cent relative humidity room conditions), with types of comfort applications which have maximum ratio values in the region of those listed:

Value of Ratio, Latent Heat to Total Heat	Typical Space	Necessary Supply Temperature of a Saturating Conditioner (in General Not Metallic Coils) to Maintain 80 F D.B. and 50% R.H.
0	Interior, no occupants or vapor	59.8 F at Dewpoint
0.05	Offices, private	59.0 " " "
0.1	Offices, tight windows and doors	58.2 " " "
0.15	Offices, 50-80 sq ft per person	57.2 " " "
0.2	Restaurant and active gen. office	56.5 " " "
0.25	Auditoria	53.9 " " "
0.3	Auditoria and luncheonettes	51.0 " " "
0.35	Ball rooms	47.2 " " "

This is a very useful and valuable table where the peak load occurs at the design conditions given which are those for general practice, and may be employed directly for spray dehumidifiers. These temperatures for spray dehumidifiers are for use in design or checking proposals employing metallic surface coils in a manner about to be outlined and *are independent of the volume of air necessary,* for this volume is thereupon a function only of the quantitative amount of heat to be absorbed by any particular system.

It is an interesting psychrometric phenomenon that the highest latent to total heat ratio which can be maintained *with a saturated supply* while producing 80 F and 50 per cent room conditions is 0.39, for which the temperature is 37.5 F; for these room conditions, a value of 0.4 or greater cannot be maintained at all with a saturated supply. To mention this may seem a bit impractical, but with the increasing use of aspirating outlets it contains the caution that it is not outside the realm of the impossible to attempt the impossible, even in air conditioning. Aspirating outlets enable the use of a saturated supply with small ducts and although a ratio of 0.4 is rare in comfort work, this condition sometimes obtains but is readily disclosed on analysis of the heat loads prior to design.

Now, a psychrometric chart can be thought of as an area containing an infinite number of points each of which spots *both* an air (dry bulb) temperature *and* the *amount* of contained water vapor. If both the temperature and vapor content scales are linear (that is, laid out in evenly spaced increments) we can draw a straight line from the room conditions to the temperature on the

"I find the article in the August issue on "Choosing the Right Air Conditioning System" very interesting; where can I get the other articles in this series?"—

Plant Engineer.

100 per cent relative humidity line as found directly from the above table, assuming of course that the design under consideration is to maintain 80 F D. B. with 50 per cent R. H. at a time when the ratio of latent to total heat absorption is maximum. Now, by adjusting the air volume delivered in accordance with the dry bulb temperature rise, it is possible to maintain the desired room conditions by supplying air *at any point on this line*. On the one hand, we do not supply air say, only 4 F below room temperature at maximum load. Ducts would be enormous and air motion objectionable. Nor do we as a general thing deliver saturated air to the outlets, especially with metallic coils, for to not do so is one of the advantages of the metallic coil as it permits, as a rule, of a better compromise of distribution requirements with refrigeration minimum operating temperature levels for better economic balance.

Picture a system not employing either a fixed or automatic coil bypass in which it is desired to maintain 80 F and 50 per cent relative humidity when the refrigeration load is found to be maximum when taken in conjunction with coil performance charactertistics and the various entering air conditions into the coils, and that the overall heat emission ratio, including duct gains and fan heat, is computed to be 0.22. By approximate interpolation from the table, a saturated supply would have to be at 55.5 F; but with a coil, we could establish the minimum entering temperature (ahead of outlets) anywhere on the line connecting the following psychrometric chart points, chosen at each decrease in relative humidity in units of 10 per cent arbitrarily:

Relative Humidities %	Dry Bulb, F	Wet Bulb, F	Corresponding Dewpoint Temp, F	Per Cent Minimum Air Volume
100	55.5	55.5	55.5	100
90	59.0	57.5	56.0	116.5
80	62.5	59.0	56.5	140
70	68.0	61.5	57.5	189
60	73.0	64.0	58.7	350

(*See psychrometric chart, below*)

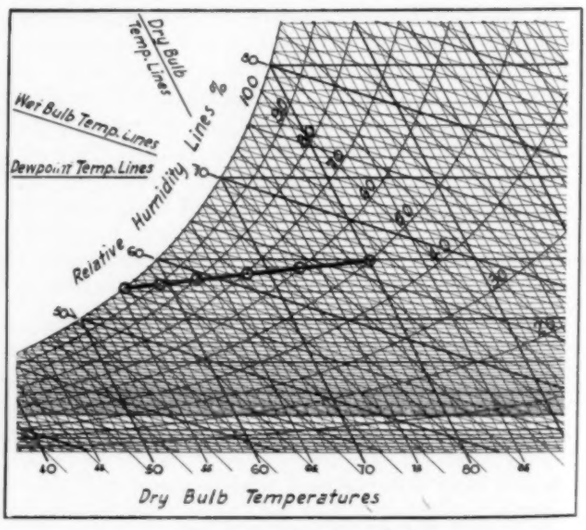
The temperature rise of the *delivered* air is next chosen for the distribution conditions, the temperature of the air *behind* the outlets next established in accordance with the amount of aspiration desired by the outlets, then allowance for temperature rise between the coils and the outlets made, and this temperature resulting when spotted on the line drawn on the psychrometric chart will establish the minimum dry *and wet bulb* temperatures at which the air must leave the conditioner or coils. Design of the coil and amount of coil surface do not matter, insofar as the air gets to that condition. The air on that job *must* get to that condition. That is first and foremost, and details are contingent thereon. Of course, coils are to be chosen for efficiency and low cost.

If a certain maximum relative humidity is to be secured at certain room conditions, the leaving conditions of the unit should lie on or very near the ratio line, but not above. Lines may be drawn for the calculated heat ratio value from the dewpoint temperatures in the second previous table to the 80 degree dry bulb and 50 per cent R. H. point on a suitable psychrometric chart, for 80 F and 50 per cent only.

It makes no difference if a spray dehumidifier is used, for the rules given are inviolate. The only difference between a bypass coil system and a bypass spray system is that the additional amount of air over and above that required with a saturated supply is bypassed on a spray job, for the air leaving the conditioner proper is saturated; this additional amount being added to gain the desired minimum delivery temperature for distribution. However, the coils may be selected, in conjunction with temperature level of water or refrigerant to produce practically any percentage of saturation. While the coils cannot always be selected to produce the exact leaving conditions chosen on our straight line, selection is amply possible within practical limits. But the spray and bypass can be adjusted virtually to perfection, and its intrinsic worth is its flexibility after installation, in the author's opinion.

Note, too, that points on the same straight line are to be chosen for either method; the points chosen for the respective methods to be wherever the best economic balance is secured for the system, which differs in the cost and efficiencies of the two. The addition of more *recirculated air* over and above the minimum required for distribution provides the volume of bypassing allotted for control purposes, and for the same effective reduction of capacity does not have to be as great an additional amount for the coil as with the saturating spray method. With given system conditions and specified minimum delivery temperature at maximum load, the air volume delivered must be the same, sprays or coils.

Now, as the heat load becomes less, and presuming the delivered volume is to be kept substantially constant, the delivery temperature behind the outlets and, therefore, leaving the coils, must shift to the right along the line drawn on the chart. At the same time, as is usually the case, there is less water vapor to be absorbed as the sensible heat nears low percentages of its peak, and with a given amount of sensible heat considered in terms of per cent of the maximum, the condition of the air leaving the coils as established by the wet bulb temperature taken with whatever dry bulb is necessary, can be thought of as being established on a line which makes a smaller angle with the constant vapor line (or dewpoint temperature line) through the room conditions, as compared to the angle for the drawn line corresponding to the H_1/H_t maximum. In other words, on any given installation, the value of the ratio of the latent to



Part of psychrometric chart, with points illustrating example given in text

Choosing the Right Air Conditioning System, by A. Warren Canney

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Previous articles in this series were published in the following issues of HEATING, PIPING AND AIR CONDITIONING:

November, 1934—What Is the Proper Viewpoint?

December, 1934—Methods and Equipment

February, 1935—Central and Unit Systems

April, 1935—Fundamental Considerations

June, 1935—Fundamental Considerations (continued)

August, 1935—Central Station Systems

total heat changes from time to time *as well as* does the amount of sensible heat.

Ideal automatic control will follow both while varying the supply air conditions in virtual stability with the instantaneous rates of changes of both of these factors independently. While it is true that a lower relative humidity from the conventional design figure of 50 per cent is not objectionable, the difficulty is that each coil has its own performance characteristics and all it knows is the entering air conditions, air velocity, the specific and internal gradient temperatures of the refrigerant or water or brine and, if direct expansion, the exact distribution as between liquid and gas. Coils, of themselves, don't know anything about *variations* in the heat ratio or per cent sensible heat, much less both; but they can be intelligently selected so as to meet the maximum load together with the maximum ratio requirements. In this connection, it is to be noted that coils must have their own ratio of heat performance as established by the relation of the entering conditions of outdoor and return air mixtures and the leaving conditions established as above by the designer. Note, too, in the previous table, how the dew point of the supply rises, approaching the room dew point as the properly adjusted air volume considered for delivery is increased.

The inability of coils, without some subdivision of refrigerant flow, or adjustable leaving gas temperature, or split coil bypass, or differential refrigerant, or air volume bypass controls, or a combination of these to make some attempt to compensate for variations in the heat load characteristics, especially with the higher values of the load ratios, or where the bulk of the load in its variation does not bear some relation between vapor and sensible heat emissions, constitutes one of the weaknesses of this method. In choosing the right air conditioning method, the practical question of importance is to determine whether control measures should be taken to offset this limiting characteristic, and their extent.

A second matter of prime importance with surface coils is the subdivision of applied refrigeration capacity both for economy and to secure reasonably good dry bulb temperature control. This can be effected fairly suitably with independent condensing units. The low average net load on most comfort air conditioning systems is surprising; but it is the considerable number of hours when the load runs around 30 to 40 per cent which puts surface cooling to the test.

This brings us to the third main point, which is controlling the plant so as to avoid drafts, over-cooling and uneconomical operation possibly all rolled into one as a result of non-correlation of applied capacities to the load, together with the inherent tendency of any thermal system under control to cycle. Only careful plant design, capacity subdivision and properly correlated control will enable systems to produce the results for which they are really bought, for the mere acquisition of sufficient capacity is by no means a complete answer to translating cash to a sound and satisfactory investment in air conditioning.

The author has attempted to confine himself to matters in which confusion has arisen to some degree in the minds of buyers, uncomplicated by the usual references to specific equipment. For this reason, descriptions of control methods, or the several very different refrigeration methods, have been omitted.

Club Cuts Fuel Cost One-Third

By **R. J. Purcell***

Modernizing for Profit

Proper modernization of hotel and club boiler plants frequently can effect large savings in fuel expense. For example, a prominent New York club, by equipping three boilers with forced draft equipment to permit the use of small size anthracite coal, saved one-third of its fuel cost.

This club had been operating their three 75 hp boilers with natural draft, burning a mixture of No. 1 buckwheat and pea coal, 7 tons per 24 hours of operation. A blower was installed in each of the three boilers and the burning of a mixture of rice and barley coal of the same heat value, at a cost of $5.38 per ton as against the cost of $7.38 per ton for the mixture of buckwheat and pea coal, was made possible. As no greater tonnage was required, a saving was thereby obtained.

In addition the total rate of evaporation was so increased, that any two of the boilers can supply as much steam as the three boilers under natural draft, permitting one boiler to be left entirely out of service, instead of being kept on the line with a banked fire as a standby unit to assist in carrying the instantaneous peak loads.

*Combustion Engr., L. J. Wing Mfg. Co., New York, N. Y.

Simplified Method *for* Solving Piping Problems

By **Siegfried W. Spielvogel*** *and* **Samuel Kameros†**

Part 2, concluding the discussion of a simplified method for checking an assumed piping layout for the intensity of end reactions and the determination of bending moments.....Figures 8-13 give original data not available elsewhere

IN a previous article[1] the authors presented a brief outline of the underlying principles in the design of pipe lines subjected to expansion and described six distinct steps for determining the end reactions set up in fully restrained lines. The application of the method was demonstrated by two numerical examples, one giving the solution for an unsymmetrical line with supports at the same level and the other for a similar line but with supports at different levels. This concluding article gives the solutions for pipe lines with sloping and curved elements.

A sloping element introduces no difficulty nor does it add to the amount of labor involved. Caution should be exercised to assign the proper mathematical sign in calculating the product of inertia of the various branches. An inclined branch which slopes from the upper right to the lower left has a positive slope, *i. e.*, the term m, Fig 4[1], is positive. An inclined branch sloping from upper left to lower right has a negative slope and therefore m is negative. I_{xy} may be positive or negative depending upon the magnitude of the two terms of the equation given in Fig. 4.[1]

Pipe Bend with Sloped Branch

The following example gives a numerical solution for a pipe bend containing a sloped branch (Fig. 5):

Pipe is 6 in.—600 lb standard seamless pipe
Steam temperature = 750 F
Room temperature = 60 F
Coefficient of expansion, c = 6.14 in. per 100 ft
Moment of inertia of cross section of pipe, I = 37 in.^{4}
Modulus of elasticity, $E = 25.5 \times 10^6$ lb/sq in.

First: Determine the center of gravity of the pipe line.

Pipe Branch	Length l (ft)	Distance of Centroid from Left End a (ft)	$l \times a$	Distance of Centroid from Bottom b (ft)	$l \times b$
AB	30	0	0	15	450
BC	12	6	72	30	360
CD	14.142	17	240.4	25	353.5
DE	12	22	264	14	168
	$\Sigma l = 68.142$ ft		$\Sigma la = 576.4$		$\Sigma lb = 1331.5$

$$\text{Distance from left end} = \frac{\Sigma la}{\Sigma l} = \frac{576.4}{68.142} = 8.46 \text{ ft}$$

$$\text{Distance from bottom} = \frac{\Sigma lb}{\Sigma l} = \frac{1331.5}{68.142} = 19.54 \text{ ft.}$$

Second: Moment of inertia and product of inertia

Pipe Branch	I_{xx}		I_{yy}	
AB	$\frac{30^3}{12} + (30 \times 4.54^2)$	$=2868.3$	30×8.46^2	$=2147.1$
BC	12×10.46^2	$=1312.9$	$\frac{12^3}{12} + (12 \times 2.46^2)$	$= 216.6$
CD	$\left(\frac{14.142^3}{12} \times \frac{1}{2}\right) + (14.142 \times 5.46^2)$	$= 539.5$	$\left(\frac{14.142^3}{12} \times \frac{1}{2}\right) + (14.142 \times 8.54^2)$	$=1149.3$
DE	$\frac{12^3}{12} + (12 \times 5.54^2)$	$= 512.3$	12×13.54^2	$=2199.9$
		$I_{xx} = 5233.0$		$I_{yy} = 5712.9$

(Note: See Fig. 4 in the previous article.)

Product of Inertia

Pipe Branch		
AB	$30 \times (-8.46) \times (-4.54)$	$= +1152.3$
BC	$12 \times 10.46 \times (-2.46)$	$= -308.8$
CD	$-\frac{14.142^3}{24} + (14.142 \times 8.54 \times 5.46)$	$= -900.2$
DE	$12 \times 13.54 \times (-5.54)$	$= +541.6$
		$I_{xy} = +484.9$

Third:

$$\tan \alpha = \frac{I_{xy}}{I_{yy}} = \frac{484.9}{5712.9} = 0.08487$$

$$\alpha = 40°51'$$

Fourth:

$$I_{11} = I_{xx} - 2\tan \alpha \, I_{xy} + \tan^2 \alpha \, I_{yy}$$
$$= 5233 - 82.3 + 41.1 = 5191.8$$

Fifth: Expansion movements—

$$\Delta x_1 = (l \cos \alpha + l_1 \sin \alpha) \, c \, \Delta t$$

$$l \cos \alpha + l_1 \sin \alpha = (22 \times 0.9964) + (8 \times 0.0845) = 22.59 \text{ ft}$$

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†Mechanical Engineering Department, The New York Edison Company, Inc.

[1]See HEATING, PIPING AND AIR CONDITIONING, September, 1935, pp. 425-428.

$$EI\,\Delta x_1 = \frac{25.5 \times 10^6 \times 37}{144} \times \frac{6.14}{12} \times \frac{22.59}{100} = 757{,}586$$

$$\Delta y = l_1\, c\, \Delta t \ldots\ldots l_1 = 8 \text{ ft}$$

$$EI\,\Delta y = \frac{25.5 \times 10^6 \times 37}{144} \times \frac{6.14}{12} \times \frac{8}{100} = 268{,}210$$

Sixth: Reactions at *O*—

$$X_1 = \frac{EI\,\Delta x_1}{\cos^3 \alpha\, I_{11}} = \frac{757{,}586}{0.9928 \times 5191.8} = 146.9 \text{ lb}$$

$$Y_1 = \frac{EI\,\Delta y}{I_{yy}} = \frac{268{,}210}{5712.9} = 46.9 \text{ lb}$$

Reactions at *A*—

$X = X_1 \cos \alpha = 146.9 \times 0.9964 = 146.5$ lb
$Y = Y_1 + X_1 \sin \alpha = 46.9 + (146.9 \times 0.0845) = 59.4$ lb

Bending moments—

At *A* (146.5 × 19.54) − (59.4 × 8.46) = + 2359 ft lb
B (−146.5 × 10.46) − (59.4 × 8.46) = − 2034 " "
C (−146.5 × 10.46) + (59.4 × 3.54) = − 1322 " "
D (−146.5 × 0.46) + (59.4 × 13.54) = + 737 " "
E (146.5 × 11.54) + (59.4 × 13.54) = + 2494 " "

Combination of Straight and Curved Elements

In the following example of a pipe line consisting of straight and curved branches the assumptions regarding pipe size and thermal expansion are the same as those used for the preceding problem. Before entering into the numerical solution it will be necessary to discuss

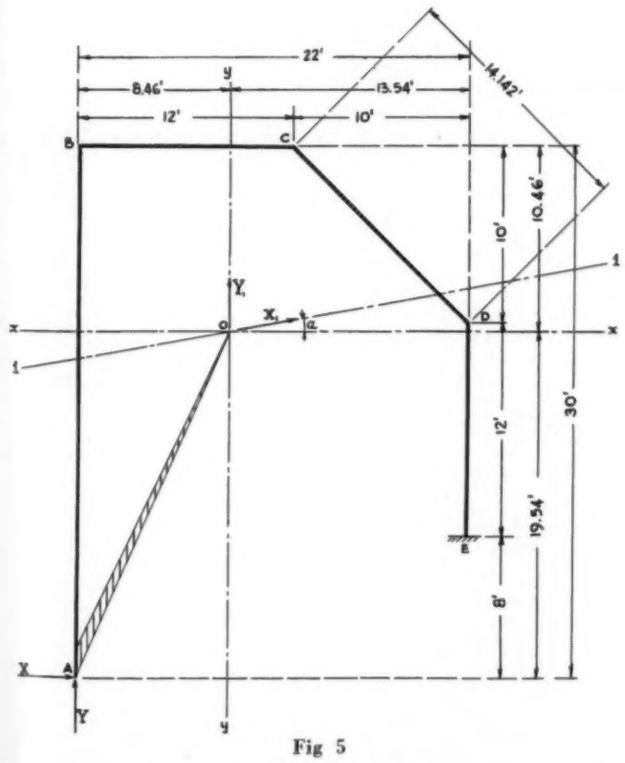


Fig 5

the so-called "Flexibility Constant," K, a term which enters into the computation of all piping problems with curved elements.

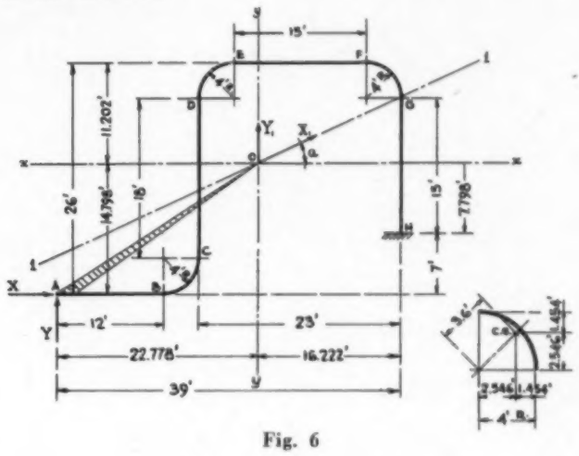


Fig. 6

A curved pipe subjected to bending stresses tends to flatten. Its cross-section assumes an elliptical shape and its flexibility increases. Experimental research has resulted in the formulation of an empirical equation which expresses this increased flexibility as a function of the pipe dimensions and the radius of curvature of the bend.

Let t denote the pipe wall thickness in inches,
r the mean radius of the pipe section in inches,
and R the radius of curvature of the pipe bend to the center of the pipe section in inches

Then

$$K = \frac{10 + 12\lambda^2}{1 + 12\lambda^2}$$

where

$$\lambda = \frac{tR}{r^2}$$

(Note that K increases with the radius of curvature of the bend).

It is evident that the flattening of the curved portions of a pipe line modifies the location of the centroid as well as the moments of inertia and product of inertia of the entire line. The modified center of gravity is known as the "Elastic Center" and its location is computed by introducing the flexibility constant in the manner illustrated in the following example. Data for computing the centroid, moments of inertia and product of inertia for most types of bends used in piping work will be found in the accompanying diagrams.

Flexibility Constant—

$$\lambda = \frac{tR}{r^2} = \frac{0.385 \times 4 \times 12}{3.12^2} = 1.9$$

$$K = \frac{10 + 12\lambda^2}{1 + 12\lambda^2} = 1.20$$

First: Elastic Center. (Compute length, s, of each bend)—

$$s = \frac{\pi R}{2} = 6.28 \text{ ft}$$

Compute the modified lengths Ks for each curved portion.

$$Ks = 1.2 \times 6.28 = 7.539 \text{ ft}$$

$C = \frac{R \sin \theta}{\theta}$

ANGLE, 2θ	DISTANCE, C
45°	0.9745 R
90°	0.9003 R
135°	0.7842 R
180°	0.6366 R

Fig. 7—Centroid of circular arc

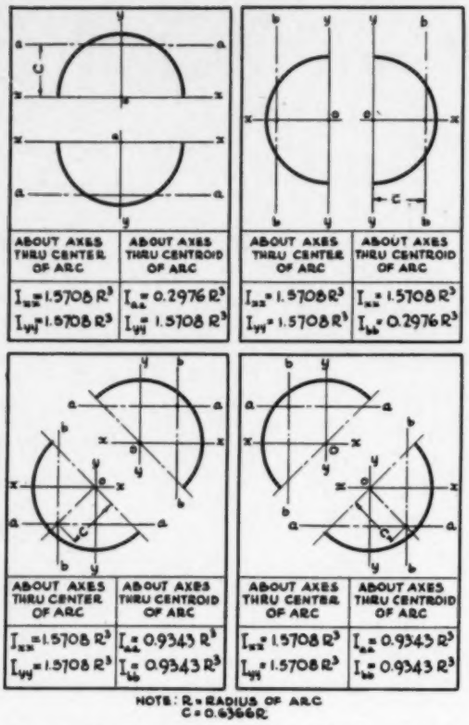

ABOUT AXES THRU CENTER OF ARC
ABOUT AXES THRU CENTROID OF ARC
$I_{xx} = 1.5708\ R^3$
$I_{yy} = 1.5708\ R^3$
$I_{aa} = 0.2976\ R^3$
$I_{yy} = 1.5708\ R^3$
$I_{xx} = 1.5708\ R^3$
$I_{yy} = 1.5708\ R^3$
$I_{aa} = 1.5708\ R^3$
$I_{bb} = 0.2976\ R^3$
$I_{xx} = 0.7854\ R^3$
$I_{yy} = 0.7854\ R^3$
$I_{aa} = 0.1488\ R^3$
$I_{bb} = 0.1488\ R^3$
$I_{xx} = 1.5708\ R^3$
$I_{yy} = 1.5708\ R^3$
$I_{aa} = 0.9343\ R^3$
$I_{bb} = 0.9343\ R^3$
$I_{xx} = 1.5708\ R^3$
$I_{yy} = 1.5708\ R^3$
$I_{aa} = 0.9343\ R^3$
$I_{bb} = 0.9343\ R^3$
NOTE: R = RADIUS OF ARC
C = 0.6366R

Fig. 8—Moments of inertia of 180 degree arcs

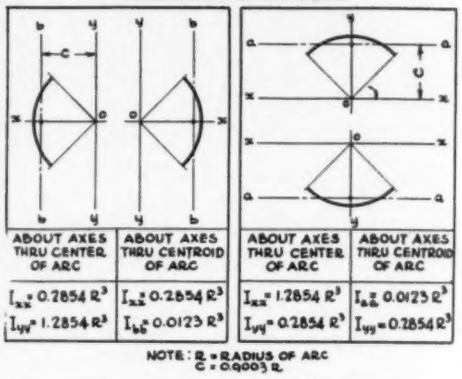

ABOUT AXES THRU CENTER OF ARC
ABOUT AXES THRU CENTROID OF ARC
$I_{xx} = 0.7854\ R^3$
$I_{yy} = 1.2854\ R^3$
$I_{xx} = 0.2854\ R^3$
$I_{bb} = 0.0123\ R^3$
$I_{xx} = 1.2854\ R^3$
$I_{yy} = 0.2854\ R^3$
$I_{xx} = 0.0123\ R^3$
$I_{yy} = 0.2854\ R^3$
NOTE: R = RADIUS OF ARC
C = 0.9003 R

Fig. 9—Moments of inertia of 90 degree arcs

Distance of elastic center from right end:

Note: For centroids of circular arcs, see Fig. 7.

Branch	l (ft)	a (ft)		
AB	15	× 0	=	0
BC	7.539	× 1.454	=	10.9
CD	15	× 11.5	=	172.5
DE	7.539	× 21.546	=	162.4
EF	18	× 23	=	414
FG	7.539	× 24.454	=	184.4
GH	12	× 33	=	396
	82.617			1340.2

$$\frac{1340.2}{82.617} = 16.222 \text{ ft}$$

Distance of elastic center from top:

Branch	l (ft)	b (ft)	
AB	12	× 26	= 312
BC	7.539	× 24.546	= 185.1
CD	18	× 13	= 234
DE	7.539	× 1.454	= 10.9
EF	15	× 0	= 0
FG	7.539	× 1.454	= 10.9
GH	15	× 11.5	= 172.5
	82.617		925.4

$$\frac{925.4}{82.617} = 11.202 \text{ ft.}$$

Second: Moments of Inertia and Product of Inertia—

(Note: The moment of inertia of an arc with respect to an external axis is equal to the sum of the moment of inertia with respect to a line through its centroid parallel to the axis and the product of the length of the arc and the square of the distance between the two axes. For piping problems the flexibility constant is introduced as shown below. The product of inertia for typical arcs is given in accompanying figures. For piping problems the equations as given must be multiplied by the flexibility constant. Care must be taken to assign to the values h and k, the coordinates of the center of the arc, proper signs, negative or positive, depending upon their locations with respect to the axes x-x and y-y.)

Moment of Inertia about Axis x-x:

Pipe Branch	Formula		
AB	$I\bar{x}^2$	$= 12 \times 14.798^2$	= 2627.5
BC	$0.1488R^3 + K s\bar{y}^2$	$= (0.1488 \times 64) + (7.539 \times 13.344^2)$	= 1351.9
CD	$0.0833l^3 + l\bar{y}^2$	$= (0.0833 \times 18^3) + (18 \times 1.798^2)$	= 544.2
DE	$0.1488R^3 + K s\bar{y}^2$	$= (0.1488 \times 64) + (7.539 \times 9.748^2)$	= 725.9
EF	$I\bar{x}^2$	$= 15 \times 11.202^2$	= 1882.3
FG	$0.1488R^3 + K s\bar{y}^2$	$= (0.1488 \times 64) + (7.539 \times 9.748^2)$	= 725.9
GH	$0.0833l^3 + l\bar{y}^2$	$= (0.0833 \times 15^3) + (15 \times 0.298^2)$	= 282.6
			$I_{xx} = 8140.3$

Moment of Inertia about Axis y-y:

Pipe Branch	Formula		
AB	$0.0833l^3 + l\bar{x}^2$	$= (0.0833 \times 12^3) + (12 \times 16.778^2)$	= 3542.0
BC	$0.1488R^3 + K s\bar{x}^2$	$= (0.1488 \times 64) + (7.539 \times 8.232^2)$	= 520.4
CD	$I\bar{x}^2$	$= 18 \times 6.778^2$	= 826.9
DE	$0.1488R^3 + K s\bar{x}^2$	$= (0.1488 \times 64) + (7.539 \times 5.324^2)$	= 223.2
EF	$0.0833l^3 + l\bar{x}^2$	$= (0.0833 \times 15^3) + (15 \times 4.722^2)$	= 615.8
FG	$0.1488R^3 + K s\bar{x}^2$	$= (0.1488 \times 64) + (7.539 \times 14.768^2)$	= 1653.7
GH	$I\bar{x}^2$	$= 15 \times 16.222^2$	= 3947.3
			$I_{yy} = 11329.3$

(Note: The symbols $\bar{x}$ and $\bar{y}$ denote the coordinates of the centroid of the pipe branch with respect to axes x-x and y-y.)

Product of Inertia about Axes x-x and y-y:

Pipe Branch	Formula		
AB	1	$12 \times (-14.798) \times (-16.778)$	= +2979.4
BC	2	$1.2(-32.0 - 0.32 + 731.24)$	= +838.7
CD	1	$18 \times (-6.778) \times (-1.798)$	= + 219.4
DE	3	$1.2(-32.0 - 159.68 - 125.71)$	= −380.9
EF	1	$15 \times 11.202 \times 4.722$	= + 793.4
FG	4	$1.2(32.0 + 310.78 + 553.06)$	= +1075.0
GH	1	$15 \times 16.222 \times (-0.298)$	= − 72.5
			$I_{xy} = +\ 5452.5$

Formula 1: $I_{xy} = I_{\bar{x}\bar{y}}$

Formula 2: $I_{xy} = K[-0.5R^3 - (h-k)R^2 + 1.5708\ hkR]$

Formula 3: $I_{xy} = K[-0.5R^3 + (h-k)R^2 + 1.5708\ hkR]$

Formula 4: $I_{xy} = K[+0.5R^3 + (h+k)R^2 + 1.5708\ hkR]$

Third:

$$\tan \alpha = \frac{I_{yx}}{I_{yy}} = \frac{5452.5}{11329.3} = 0.4813$$

$$\alpha = 25^\circ\ 42'$$

Fourth:

$$I_{11} = I_{xx} - 2 \tan \alpha\, I_{xy} + \tan^2 \alpha\, I_{yy}$$

$$= 8140.3 - 5248.6 + 2623.9 = 5515.6$$

Fifth: Expansion Movements—

$$l' = l \cos \alpha + l_1 \sin \alpha$$

$$= (39 \times 0.9011) + (7 \times 0.4337) = 38.1788 \text{ ft}$$

$$EI \triangle x_1 = \frac{25.5 \times 10^6 \times 37}{144} \times \frac{6.14}{12} \times \frac{38.1788}{100} = 1{,}280{,}061$$

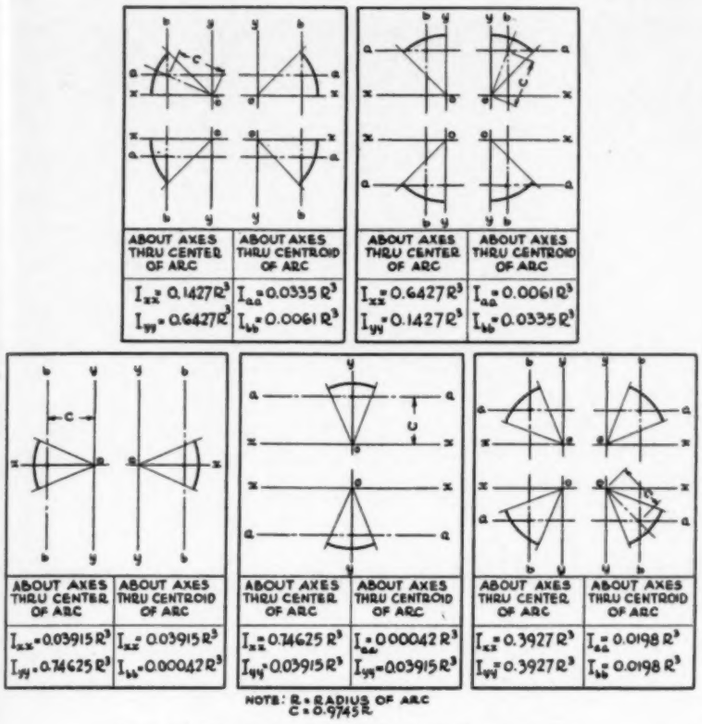

ABOUT AXES THRU CENTER OF ARC
ABOUT AXES THRU CENTROID OF ARC
$I_{xx}=0.1427R^3$ $I_{aa}=0.0335R^3$ $I_{yy}=0.6427R^3$ $I_{bb}=0.0061R^3$
$I_{xx}=0.6427R^3$ $I_{aa}=0.0061R^3$ $I_{yy}=0.1427R^3$ $I_{bb}=0.0335R^3$
$I_{xx}=0.03915R^3$ $I_{aa}=0.03915R^3$ $I_{yy}=0.14625R^3$ $I_{bb}=0.00042R^3$
$I_{xx}=0.14625R^3$ $I_{aa}=0.00042R^3$ $I_{yy}=0.03915R^3$ $I_{bb}=0.03915R^3$
$I_{xx}=0.3927R^3$ $I_{aa}=0.0198R^3$ $I_{yy}=0.3927R^3$ $I_{bb}=0.0198R^3$
NOTE: R = RADIUS OF ARC
C = 0.9745R

Fig. 10—Moments of inertia of 45 degree arcs

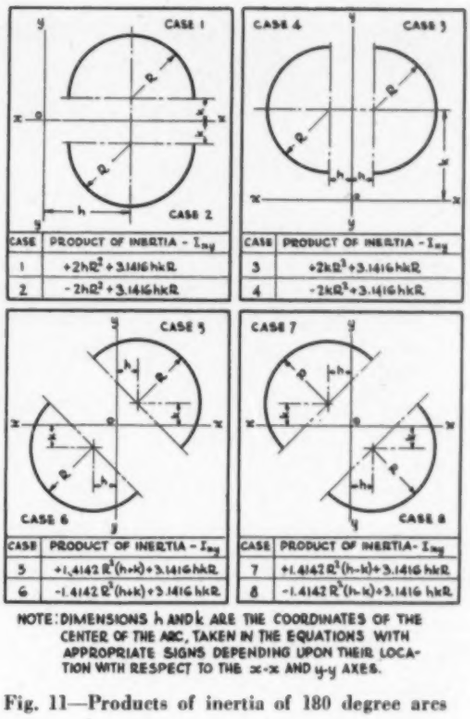

CASE 1
CASE 2
CASE 3
CASE 4
CASE 5
CASE 6
CASE 7
CASE 8
CASE | PRODUCT OF INERTIA - I_{xy}
1 | $+2hR^2+3.1416hkR$
2 | $-2hR^2+3.1416hkR$
3 | $+2kR^2+3.1416hkR$
4 | $-2kR^2+3.1416hkR$
5 | $+1.4142R^2(h+k)+3.1416hkR$
6 | $-1.4142R^2(h+k)+3.1416hkR$
7 | $+1.4142R^2(h-k)+3.1416hkR$
8 | $-1.4142R^2(h-k)+3.1416hkR$
NOTE: DIMENSIONS h AND k ARE THE COORDINATES OF THE CENTER OF THE ARC, TAKEN IN THE EQUATIONS WITH APPROPRIATE SIGNS DEPENDING UPON THEIR LOCATION WITH RESPECT TO THE x-x AND y-y AXES.

Fig. 11—Products of inertia of 180 degree arcs

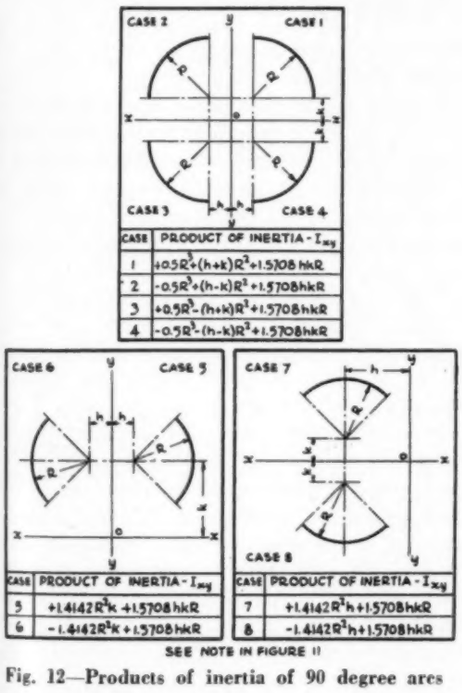


Fig. 12—Products of inertia of 90 degree arcs

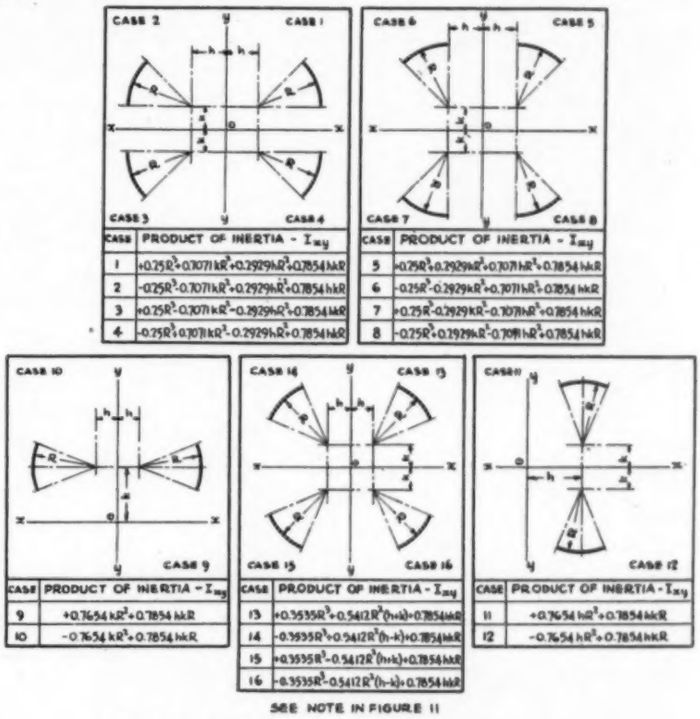


Fig. 13—Products of inertia of 45 degree arcs

$$EI\,\Delta y = \frac{25.5 \times 10^6 \times 37}{144} \times \frac{6.14}{12} \times \frac{7}{100} = 234{,}696$$

Sixth: Reactions at *O*—

$$X_1 = \frac{EI\Delta x_1}{\cos^2\alpha I_{11}} = \frac{1{,}280{,}061}{0.812 \times 5515.6} = 285.81 \text{ lb}$$

$$Y_1 = \frac{EI\Delta y}{I_{yy}} = \frac{234{,}696}{11329.3} = 20.71 \text{ lb}$$

Reactions at A—

$X = X_1 \cos\alpha = 285.81 \times 0.9011 = 257.54$ lb

$Y = X_1 \sin\alpha + Y_1 = (285.81 \times 0.4337) + 20.71 = 144.67$ lb

Bending Moments:

At *A* $(-14.798 \times 257.54) + (22.778 \times 144.67) = -515.8$ ft lb
At *B* $(-14.798 \times 257.54) + (10.778 \times 144.67) = -2251.8$ ft lb
At *C* $(-10.798 \times 257.54) + (6.778 \times 144.67) = -1800.3$ ft lb
At *D* $(+7.202 \times 257.54) + (6.778 \times 144.67) = +2835.4$ ft lb
At *E* $(+11.202 \times 257.54) + (2.778 \times 144.67) = +3286.9$ ft lb
At *F* $(+11.202 \times 257.54) - (12.222 \times 144.67) = +1116.8$ ft lb
At *G* $(+7.202 \times 257.54) - (16.222 \times 144.67) = -492.0$ ft lb
At *H* $(-7.798 \times 257.54) - (16.222 \times 144.67) = -4355.1$ ft lb

Moments of Inertia and Product of Inertia of Circular Arcs

The moments of inertia of any circular arc about two rectangular axes passing through the center of the circle are given by the equations:

$$I_{xx} = \tfrac{1}{2} R^3 \left[\theta - \tfrac{1}{2}\sin 2\theta\right]_{\theta_1}^{\theta_2}$$

$$I_{yy} = \tfrac{1}{2} R^3 \left[\theta + \tfrac{1}{2}\sin 2\theta\right]_{\theta_1}^{\theta_2}$$

The product of inertia of any circular arc about any two rectangular axes is given by the equation:

$$I_{xy} = \left[\tfrac{1}{2} R^3 \sin^2\theta + kR^3 \sin\theta - hR^3\cos\theta + hkR\theta\right]_{\theta_1}^{\theta_2}$$

In these equations the terms are as follows:

R = the radius of the circular arc

θ_1 = the angle of the first limit of the arc above the horizontal axis measured counter-clockwise, expressed in radians

θ_2 = the angle of the second limit of the arc above the horizontal axis measured counter-clockwise, expressed in radians

h = the horizontal coordinate of the center of the circle measured from the reference axis

k = the vertical coordinate of the center of the circle measured from the reference axis

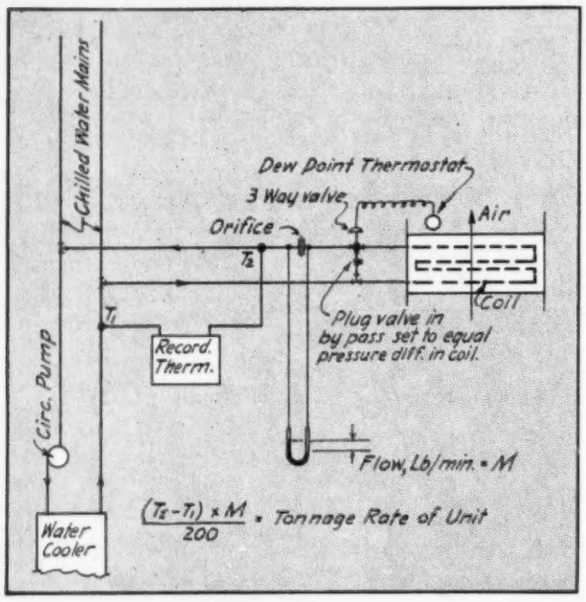
The evaluation of the above equations is performed by first substituting the angle θ_2 in the equation and then doing the same with θ_1 and finally subtracting the second evaluation from the first.

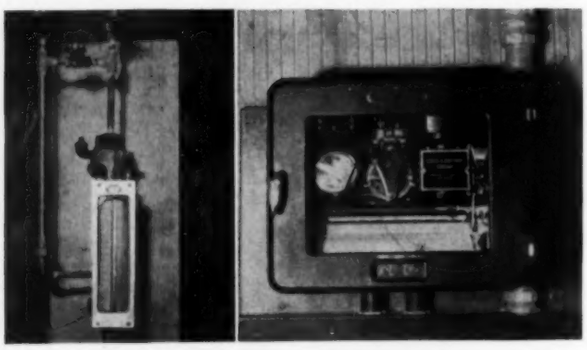
Figs. 8, 9 and 10 give the moments of inertia and Figs. 11, 12 and 13 the products of inertia for the various locations of 45, 90 and 180 degree arcs. These arcs are most commonly used in piping work. For angles other than these the equations given above should be used.

Metering Air Conditioning Output . . . . . *By* Wm. H. Junker*

WHERE the building management provides air conditioning service to several different tenants, and the tenants pay for the cost of air conditioning, the question of metering upon which the billing may be based is presented. As a direct reading and recording air conditioning "tonnage" meter is not available at present, we are using the method outlined in the sketch.

*Mechanical Engineer, Thomas Emery's Sons, Inc., Cincinnati, Ohio.





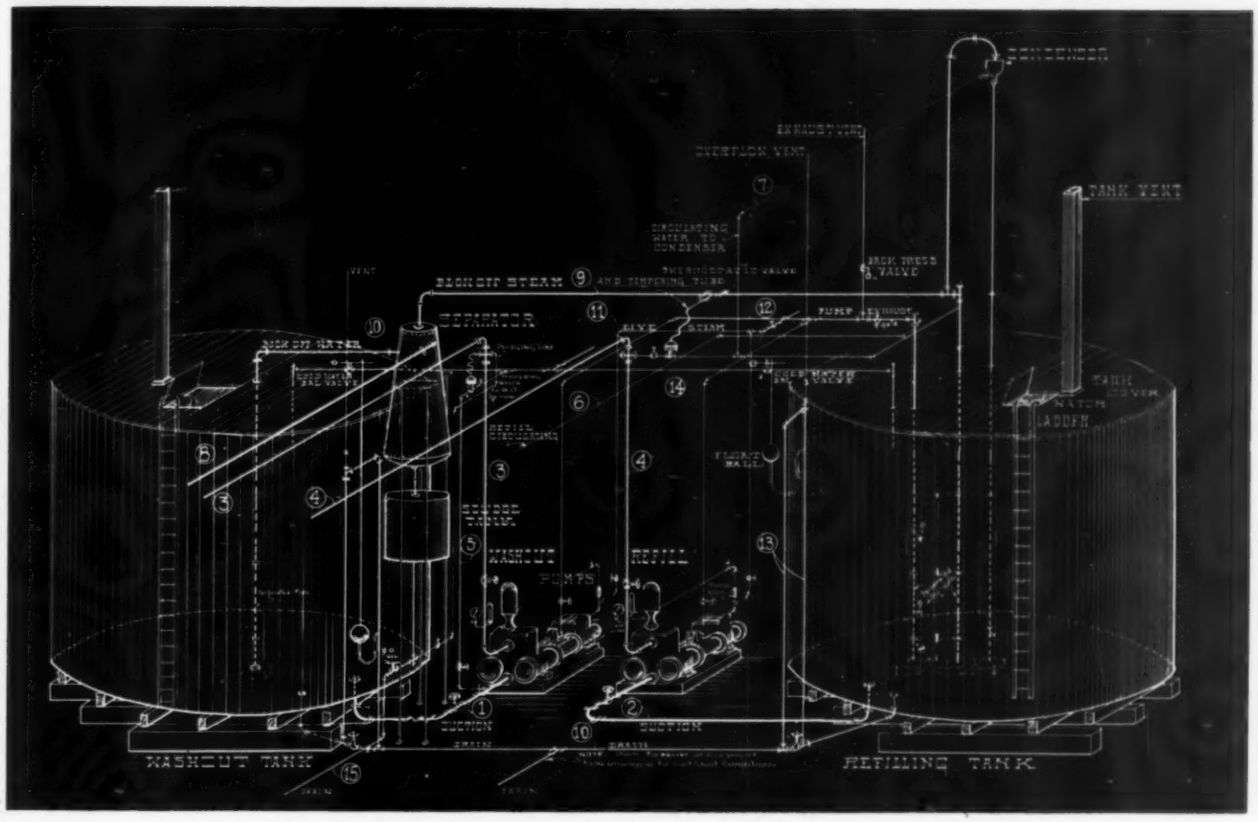
Arrangement and instruments for metering air conditioning output

Each air conditioning unit comprises a closed circuit chilled water cooling coil over which air is passed. The water is pumped to each coil at approximately 45 F; maximum temperature rise of the water through the coil is about 10 F. The units range in capacity from about 5 to 40 tons, the largest requiring approximately 48,000 lb of water per hr.

A resistance type strip chart recording thermometer with ten points is used. One point records the base temperature of the chilled water, *i. e.*, temperature of the water leaving the cooler. The other nine points record the return water temperatures from each of nine individual air conditioning units. The quantity of water flowing to each unit is held constant by means of a three-way valve in the bypass as diagrammed, and this quantity is indicated by a direct reading manometer with square root scale. A system of pressure tubing and valved headers at the manometer allows the one instrument to serve several orifice plates.

Thus, the temperature difference of the water in and out of the coil multiplied by the flow of water through the coil in lb per min establishes the tonnage output of the air conditioning unit. For instance, if 20 lb per min passed through one of the coils with a temperature rise of 10 F, one ton of refrigeration is absorbed by the unit, as a ton is defined as a rate of heat exchange of 200 Btu per min.

The total tonnage is computed monthly by means of a special planimeter which is used to circumscribe the area on a chart bounded by the base points (temperature of water entering coils) and the respective air conditioning unit points (temperature of water leaving coils). This area, divided by the unit of time selected, gives the mean rise in temperature which, when multiplied by the rate of water flow (a constant), gives the result in tons of refrigeration absorbed by the unit. In addition to the monthly "energy" charge determined in this way and which represents the cost of operating the equipment, a maximum seasonal demand charge is made to cover capital investment, depreciation, etc.



Diagrammatic layout of heater room piping, locomotive boiler washing system (patented). This type of drawing aids operation and maintenance of plant and building piping systems

1—Washout pump suction
2—Refill pump suction
3—Washout main
4—Refilling main
5—Tempering water to washout suction
6—Refill circulating line
7—Circulating water to condenser
8—Blow off from round house to separator
9—Blow off steam to condenser
10—Blow off water
11—Live steam to pumps
12—Exhaust steam from pumps
13—Overflow risers and drains
14—Cold water supply to tanks
15—Separator drain
16—Tank drains

PIPING POINTERS

By **B. C. Rinehart***

AN isometric drawing of a complete piping system showing at a glance all valves, regulators, etc., and posted in a convenient location, is of considerable aid to normal operation and maintenance and is invaluable in emergencies. This type of drawing has the advantage of being easily revised when changes are made in the piping.

In operating a piping system there is always a possibility of conditions arising that require the most expeditious means of locating various valves and fittings. This may come about in many ways, such as a leak that requires quick and immediate shutting off of the line. In most cases the engineer in charge can do this without any reference to drawings or charts; however, he may be temporarily absent and it becomes necessary for some one not so familiar with the location of the valves to do so. Many industrial piping systems require the throttling or "cracking" of valves at times. Naturally, a diagrammatic drawing of the system is very convenient for such purposes. Frequently, it is a good idea to color the lines in accordance with *A. S. M. E.* standards.

The writer recalls numerous incidents which prove his point. Recently a bad leak developed in one of the mains in a department store at 2 a. m. As the engineer could not be located, it was necessary to call the superintendent at his home in the suburbs. By the time he arrived, the fire department, fire insurance patrol and police department were all on the scene; the damage to merchandise would have been tremendous had he not been familiar enough with the piping immediately to give instructions for shutting off the right valve.

The accompanying drawing is presented as an example of the type which the author recommends for giving a quickly grasped picture of a piping system in a plant or building. This particular one is a diagrammatic layout of the piping and valves in the pump room of a locomotive boiler washing system, which is a piping system for washing and filling locomotives with hot water; in this system the blown off products of the locomotive are conserved for heating water in the tanks marked "washout" and "refilling" for washing and refilling the locomotive boilers with hot water.

*Chief Engineer, F. W. Miller Heating Co., Chicago, Ill.

Control of Squirrel Cage Motors

for Heating *and* Air Conditioning Service

AUTOMATIC motor control has proved its worth in air conditioning and heating—as it has in other fields—for motors driving exhaust and supply fans, compressors, condensate pumps, vacuum pumps, air filters, dehumidifying pumps, air washers, and other such apparatus. This is partly due to the additional protection afforded the motor and the machine, but more important is the fact that it permits motors to be started and stopped from remote points. Thermostats, pressure switches, float switches, and other automatic control switches can be used with automatic motor control to maintain desired conditions in a system without the attention of an operator. Obviously it is important that the design or operating engineer be familiar with the fundamental aspects of automatic motor control.

In this article, only control equipment for squirrel cage alternating current motors is considered, as this type is regarded as the general utility a-c motor.

Starting Squirrel Cage Motors

In starting squirrel cage motors for air conditioning service, two factors must be considered: First, the starting current must not be so great as to cause an appreciable drop in the line voltage, or the resulting flicker in the lamps on the same circuit will be objectionable: second, the torque must be sufficient to accelerate the load to full speed in a reasonable time.

Not so many years ago, there was but one type of squirrel cage motor—the general purpose type. In order to keep the starting current to a permissible value, it was necessary to use a starter that would reduce the line voltage. Today, so-called "line-start" squirrel cage motors are built to draw low starting current, and it is now possible to throw motors rated at 30 hp or even higher directly across the line without disturbing lighting circuits and causing lamp flicker. Many air conditioning motors, therefore, can be started directly across the line, although where local regulations are unusually strict, it may be necessary to reduce the voltage applied to the motor terminals.

Reduced voltage for motor starting is usually obtained by connecting either auto-transformers or resistors in the circuit. The auto-transformer type of starter, known as the compensator, utilizes transformers having a single tapped winding instead of a separate primary and secondary winding to reduce the voltage. The motor is first connected to the reduced voltage taps and when it has attained proper speed, is switched to the line voltage taps. These starters can be of the automatic type, operated from push-buttons or other pilot control devices.

The resistance type reduced voltage starter depends upon the insertion of resistance in the circuit to cut down the line voltage. At starting, a resistor, either fixed or variable, is placed in series with each phase of the motor winding. When the motor reaches a given speed, it is connected directly to the line. Resistance starters are manufactured in the manual, semi-automatic, or fully-automatic type. Manual starters are started and stopped by hand, while semi-automatic starters are started by hand but can be disconnected automatically by a push-button, limit switch, float switch, pressure switch, or overload relay. Fully automatic starters can be both started and stopped by pilot control devices.

Across-the-line starters which connect the motor terminals directly to full line voltage are less complicated than reduced voltage starters. The simplest type consists of a multi-pole knife switch protected by fuses. Its simplicity and low cost are its only advantages, however, for it fails to provide the proper motor protection and its contacts quickly blister and fuse. The manually operated across-the-line switch of the snap-acting type, actuated by push buttons, has been rapidly supplanting the knife switch. It has the advantage of providing greater protection to the machine and the operator, takes only a fraction of the space required by a knife switch, and the contacts have a much longer life. These switches are usually equipped with overload relays that can be reset by pressing a lever. For starting motors smaller than 5 hp at 220 volts, they are frequently used.

The National Electric Code specifies that all motors in sizes greater than 5 hp must be provided with no-voltage protection. Hence, on all larger motors it is necessary to use a starting switch in which the contacts are held in by means of a magnet, *i. e.,* an automatic starter. Any magnetically operated starter is an automatic starter, regardless of whether it is controlled manually by pressing a push-button or automatically by means of an automatic pressure or float switch. As long as the control device closes a magnetic circuit in the starter and the magnet closes the main switch, the starter is classed as an automatic starter.

Fig. 1 shows the internal construction and wiring connections of a three-phase a-c across-the-line automatic starter of the solenoid type. The starter consists of a magnetic coil *M* inside of which is a movable iron

With standard automatic motor control equipment it is possible to devise control systems to accomplish practically any desired object..... Types and operation of available equipment are described here, with information regarding applications to heating and air conditioning services

By **N. D. Buehling***

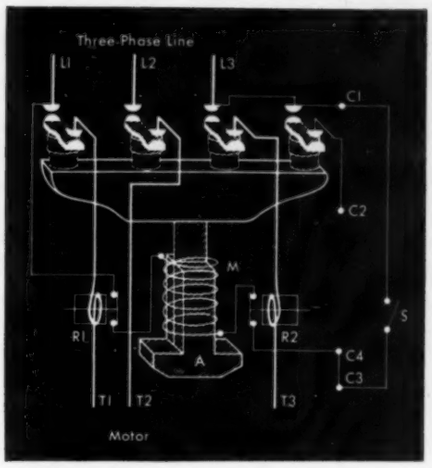


Fig. 1—Internal mechanism and connection diagram for automatic starter connected to a simple two-wire control switch

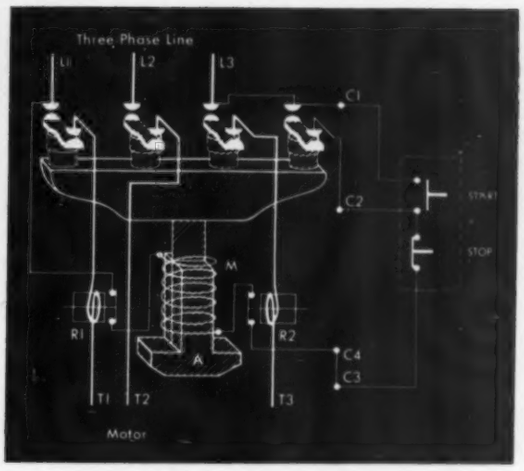


Fig. 2—Internal mechanism and connection diagram for automatic starter connected to "start-stop" push-button

armature *A*. Fastened to this iron armature, but insulated from it, are the main switch contacts. For three-phase circuits, there are three pairs of contacts and an additional pair of hold-in contacts. The main line circuit is shown by heavy lines, while the magnetic coil circuit—called the pilot control circuit or pilot circuit—is shown in lighter lines. When an external switch *S* is closed, the magnet *M* terminals are connected to the line wires *L1* and *L3*, and current flows through the winding of the coil. The magnetic action of the coil lifts the iron armature and closes the main line switch contacts. When the switch *S* is opened, the current in the pilot control circuit is broken, and the iron armature falls back, opening the main line switch contacts. In series with the main line are two overload relays *R1* and *R2* which trip at sustained overloads and open the pilot circuit, releasing the iron armature and opening the main line switch.

Fig. 2 shows the same starter connected to a "start-stop" push button. Pressing the "start" button causes the current to flow in the pilot circuit, and the switch closes. Once the switch has been closed, the finger can be removed from the button and the hold-in contacts *C1* and *C2* will maintain the current in the pilot circuit, and the starter will remain closed. When the "stop" button is pressed, the contacts of the "stop" button are opened, and the circuit of the pilot control is broken, opening the switch.

When the automatic starter is connected to a two-wire control station as in Fig. 1, a sudden failure of the line voltage will cause the switch to open. However, when the voltage is resumed, the switch will again close. With three-wire control as in Fig. 2, the switch will also open with a failure in line voltage, but when the voltage is resumed, the switch will not re-close unless the "start" button is again pressed. Thus two-wire control is said to give *no-voltage release*, while three-wire control gives *no-voltage protection*. With no-voltage protection, a machine that has been shut down because of a voltage failure cannot unexpectedly start up after a voltage failure and injure a worker or ruin a machine. Three-wire control, therefore, is usually preferred to two-wire control, unless the machine cannot possibly do any harm if it starts up unexpectedly.

*Industrial Engineer, Allen-Bradley Co., Milwaukee, Wis.

Multi-Speed Motors and Control

Multi-speed motors, particularly the two-speed type, are often ideal for driving compressors for refrigerating and air conditioning loads, and can often be used to advantage on fan drives. They are almost as flexible as slip-ring induction motors and permit the compressors or fans to drop their loads efficiently when necessary. Thus in a restaurant air conditioning system, where there is an unusual severe load during the noon lunch hour, and a sudden tapering off immediately after, a two-speed motor responds very nicely—the high speed carrying the peak loads and the low speed carrying the normal loads. Two-speed motors are also finding increased use in the refrigeration field. In packing plants little refrigeration is required to carry the normal load, but during periods of heavy killing, there is a sudden inflow of warm meat which must be dropped in temperature rapidly. In such installations, two-speed compressors can respond to sudden load demands immediately.

While possessing much of the flexibility of the slip-ring induction motor, the multi-speed squirrel cage motor has a much higher efficiency when operated at slow speeds, and the further advantage of retaining the squirrel cage motor simplicity. The control apparatus is easily applicable to automatic control. Multi-speed motors of more than two speeds, however, become rather complicated.

To change the speed of any squirrel cage motor, it is necessary only to change the number of poles. In the multi-speed squirrel cage motor, this is usually done in one of two ways: Sections of the same winding can be re-connected to give a re-grouping of the poles or a separate winding can be provided to give the desired number of poles. The multi-speed motor, therefore, is nothing more than a standard squirrel cage motor with several stator windings. By interconnecting these windings through suitable switches, a combination of two or more squirrel cage motors can be obtained, each having

a different synchronous speed. Where the separate speeds are obtained by means of separate windings, the motor is known as a "separate-winding" motor. Where the same winding is used to provide more than one speed, the motor is said to be of the "consequent pole" type.

When automatic switching is used for the control of multi-speed motors, speed selection is obtained through

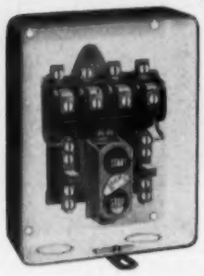


Fig. 3—Manual quick make-and-break starter

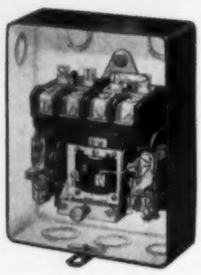


Fig. 4—Automatic solenoid type starter

push buttons. The number of main switches used on the control panel is equal to the number of speeds. Each switch controls one speed, and is in turn controlled by its proper push button. Pressing the "stop" button disconnects the motor from the line, regardless of the speed at which it happens to be operating.

Where the motor load is high, it is often desirable to eliminate the undue strains on the motor and the driven machine that occur when the motor is started from rest at high speeds. This is accomplished by means of a compelling slow-speed relay that permits starting only on the low speed. Pushing the high-speed buttons will have no result; the motor will start only when the low-speed button is pressed. Once it has reached its speed, the high-speed buttons can be pressed to speed up the motor. If a timing relay is added, as well as the compelling slow-speed relay just mentioned, it is possible to start a two-speed motor on the high speed by pressing the high-speed button. This automatically closes the low-speed switch first, and after a certain time interval, opens the low-speed and closes the high-speed switch. The sequence of operation of the switches and relays takes place without any attention on the part of the operator after he has pressed the high-speed button.

With large inertia loads, the dynamic braking effect caused by a change from a high to a low speed may be great enough to cause damage to the motor or driven machine. In order to obviate this danger the operator should give the motor sufficient time to slow down by first pushing the stop button and waiting an interval before pushing the button corresponding to the new speed. By employing special auxiliary contacts and connections, the starter can be arranged so that it is impossible to switch from a high to a lower speed without first pressing the "stop" button. Furthermore, a time-delay relay can be added so that with two-speed starters, if the low-speed button is pressed while the motor is operating in high speed, the high-speed circuit will be disconnected and there will be a suitable time-delay before the low-speed switch is automatically closed.

Two-speed motors and control have been used very successfully on refrigeration compressors automatically controlled by two thermostats. The thermostats are set so that below a certain temperature, the compressor is shut off entirely. When the temperature rises the compressor motor operates at the low speed, while as the temperature increases beyond a certain point, the compressor motor is operated at high speed. With such a system, it is customary to incorporate timing relays so as to provide a compelling slow start and an adequate time-delay when switching the motor from high speed to low speed. Such an arrangement provides a flexible means of meeting varying load conditions, and maintains the desired temperature under all loads.

Applications of Automatic Starting Equipment

There are a number of standard control switches that can be used to open and close the pilot control circuits of automatic starters, thus disconnecting and connecting motors to the line. The simplest is the common

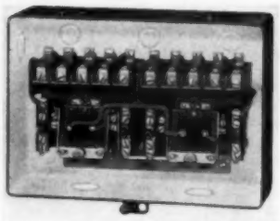


Fig. 5—Open view of automatic two speed starter

Fig. 6—Push-button station for automatic motor control

two-wire snap switch. This is often used with automatic starters on motors driving fans, pumps, and other equipment which must continue to operate without constant attention. A voltage failure will open this starter and stop the motor, but as soon as the voltage is resumed the motor will restart. With a three-wire push button it would be necessary to press the "start" button before the motor would restart, and unless an attendant was on hand the machine would remain idle.

The three-wire "start-stop" push button is the pilot control station most commonly encountered. It has a "start" and a "stop" button. The "start" button is normally open, and when it is pressed, closes its contacts momentarily. When the pressure is removed, it returns to its normal position. The starting switch remains closed, even after the pressure on the "start" button is removed and its contacts are again broken. The "stop" contacts are normally closed, but momentarily open when the button is pressed, returning to their original closed position when the pressure is removed. The starting switch, however, remains open, and to close it the "start" button must be again pressed.

Once a switch, actuated by a three-wire "start-stop" button, has been opened by a voltage failure, it will remain open even though the voltage returns. Three-wire

control, therefore, gives no-voltage protection, and for this reason is used very widely.

Where the motor is to be operated at the starter, the push-button can be built into the starter itself, or it can be entirely separate from the starter, controlling it from some remote point. Quite often, where it is desired to control a motor from any one of a number of points, push buttons are located at each of these points, and are connected in parallel. Pressing the "start" or "stop" button of any of these push-button stations will start or stop the motor.

Automatic float switches, pressure switches, and thermostats can be connected to start or stop motors when certain conditions of water level, pressure, or temperature have been attained. Thus, a thermostat in the room to be cooled or pressure switch in the suction line of a refrigeration compressor may control the compressor motor, starting it when the room temperature or suction pressure is high and shutting it down when the temperature or pressure has fallen. Similarly, a vacuum switch in the return line of a heating system may control the motor on the vacuum pump to maintain the proper vacuum in the system.

It is frequently desired to operate a fan or a compressor by means of an automatic switch for a certain period, and then to change over to manual push-button control. This can easily be done by means of the three-way selector switch, which has a lever that can be set either to "automatic" or "hand" control, or to an "off" position. These selector switches can be incorporated in the starter itself, or can be entirely separate, whichever is the more convenient for a particular job.

Snap switches are sometimes used in conjunction with automatic control switches for special jobs. Thus, by putting a snap switch in parallel with an automatic control switch, when the snap switch is closed, the starter will close, and when the snap switch is open, the motor will be controlled automatically by the control device. If the snap switch is connected in series with the automatic control device, it operates simply as a disconnect switch, either opening the pilot circuit and stopping the motor or connecting the automatic pilot control device to the circuit.

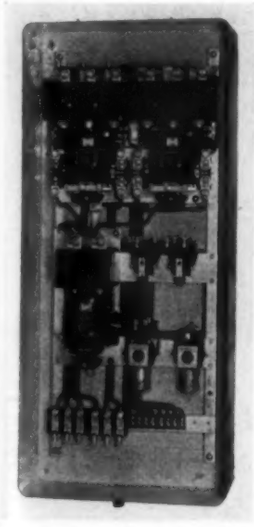


Fig. 7 — Automatic two-speed starter for consequent pole squirrel cage motors, equipped with automatic sequence accelerating and decelerating relays for thermostatic control of a compressor motor

Two motors and two starters are sometimes connected to the same control device so that both motors operate simultaneously. Thus motors operating self-cleaning filters can be electrically interlocked with the pump motor, so that all of the air cleaning equipment on a certain fan is started at the same time. If desired, a time-delay relay can be connected to one of the motors so that it will automatically start only after a predetermined time interval.

COMPARE
THE TEMPERATURES
THE TEMPERATURE INDICATOR ABOVE GIVES READINGS WHICH ARE ACCURATE TO A FRACTION OF A DEGREE. THE NEEDLE ON THE DIAL INDICATES THE OUTSIDE TEMPERATURE WHEN THE RED BULB IS LIGHTED... THE INSIDE FIELD BUILDING TEMPERATURE WHEN THE GREEN BULB IS LIGHTED

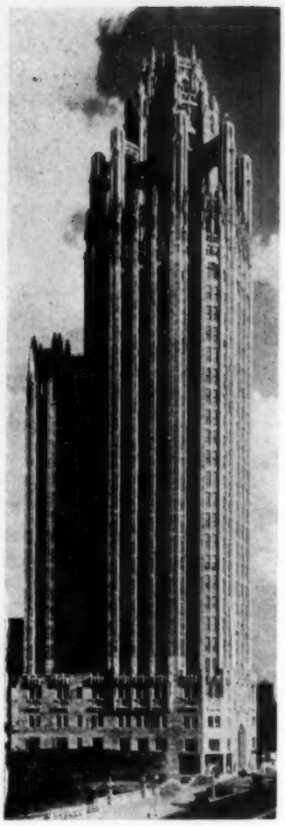
Promotional possibilities of air conditioning are capitalized upon by the Field Building, Chicago, with this thermometer display in a large LaSalle St. window. The switching of the hand from hot outside temperatures to the cool inside figure has been an object of interest to the thousands who pass the building every day

When motors are controlled from a remote point, it is usually desirable to have some method of indicating to the operator whether or not the starting switch is closed and the motor is operating. The pilot lamp is frequently used for this purpose and connected so that when the starting switch is closed the light glows. Where there is danger of pressures building up, a high-pressure cut-out is used to disconnect the motor from the line. Alarm contacts are sometimes used with automatic control devices to indicate by flashing a light or ringing a bell that the motor is shut down.

Possibilities of Automatic Motor Control

All of the equipment described in this paper is considered standard by every manufacturer. Yet with these few standard automatic starting switches, pilot control devices, and relays, it is possible to devise control systems for any special process. Motors can be stopped, started, reversed, and "plugged" in almost any desired sequence. Motors can be made to respond to almost any conditions of pressure or temperature, so as to maintain such conditions at given values. At the same time these motors can be so interlocked, that despite human error, the driven machines, the operator, and the motor itself are protected from injury. With new developments constantly being announced, it is advisable for the air conditioning engineer to check to be sure that the most efficient control equipment is used.

"What We Think of Air Conditioning"



An Interview with

Holmes Onderdonk*

AIR conditioning is as essential to profitable office building operation as elevators, hot and cold water and other conveniences long since accepted as standard services in the office building field.

That is the opinion of the Chicago *Tribune* whose widely-known Tribune Tower has just completed its second season of summer cooling; and it bases this opinion upon the general principle that the world moves on and we must move with it and confirms it with two years' experience of general tenant-satisfaction, a higher-than-average occupancy, employee-comfort and efficiency, and reasonable operating costs.

The *Tribune* decided to air condition in August 1933, put the system in operation on the first of June 1934. During the 1934 summer season the cooling system operated 1,338.5 hours, produced 16,295.7 tons of refrigeration, with a cost for coal and condensing water of $13,545.93. During the 1935 summer season the system operated 1,485 hours, produced 21,226.5 tons of refrigeration, with a cost for coal and condensing water of $4,969.59. A glance at the table of comparative costs shows that the big saving made was in condensing water.

The *Tribune* had good reasons for air conditioning. It occupies 60 per cent of its 34 story building, and its own employees' comfort on the unbearable hot days of a Chicago summer means a great deal in increased efficiency and morale.

More than that, it was figured that air conditioning would give the Tribune Tower worth while publicity and the *Tribune* could give air conditioning worth while publicity. The former would help rent space. The latter would contribute to the greater development of this relatively new industry, the development would call for advertising by the industry. Also, those who spent their days in the comfortable atmosphere of the building would want similar comfort in their homes. Thus, in another way, buying would be stimulated, the industry would be enlarged.

The Tribune Tower was built in 1925. When the management approached the selection of an air conditioning system, therefore, it was not with a building designed to accommodate every type available. Here was a structure already built which housed offices, editorial work rooms and all the manufacturing processes of a modern newspaper, in use 24 hours per day. Here, too, already built, was an organization of engineers and help operating the building. It was desirable that air conditioning be accommodated to the layout and routine already in effect . . . that the existing features of the building be maintained in every respect.

These, and the aims to be achieved, were naturally most familiar to the management and engineering staff of the building. It was decided, therefore, not to call in an outside engineer to design a system, but to call for bids from various air conditioning concerns and decide upon the one they themselves thought most applicable.

The decision was for a system which made use of a boiler plant already in—a plant which it was necessary to run anyway, but only to 5 or 10 per cent of its capacity in the summer. Utilizing it meant a saving in the original investment—meant that the only operating costs would be increased fuel and condensing water, meant that present labor or help would suffice.

A 624-ton steam jet plant was installed, with a unit system calling for 400 individual units for offices above the seventh floor, and central type units for the *Tribune* plant proper. One serves the composing room and the fifth, sixth and seventh floors of the building. Another serves the editorial room and other departments of the fourth floor . . . another the mail room . . . another the press room . . . and a fifth one the paper reel room below the presses.

That is the system which has operated these past two years. The only change made has been in the condensing water supply, a change which saved more than $8,000 in operating costs in 1935 over those of 1934. In 1934, water was taken directly from the city mains. In 1935, permission was granted to install a closed circuit from the nearby Chicago river to take water from the river to the condensers and right back to the sewer . . . an

(*Continued on page* 490)

Refrigeration Costs, Tribune Tower Air Conditioning System, for June, July, and August

	1934	1935
Total service hours	1,338.5	1,485.0
Total production, tons refrigeration[a]	16,295.7	21,226.5
Total coal chargeable, lb[b]	2,835,755	2,423,730
Total condensing costs	$9,434.15	$849.19
Total coal costs chargeable[c]	$4,111.78	$4,120.40
Total labor costs[d]		$944.64
Combined coal and condensing cost	$13,545.93	$4,969.59
Coal cost per ton refrigeration	$0.252	$0.194
Condensing cost per ton refrigeration	$0.579	$0.040
Combined coal and condensing cost per ton	$0.831	$0.234
Combined coal, condensing, and labor cost per ton	$0.831	$0.278

[a]Greater tonnage in 1935 as compared with 1934 due mainly to excessive humidity of 1935 and a greater number of hours of service.

[b]Lower coal consumption in 1935 due to using a better grade of coal and operating at a more uniform rate of output.

[c]Smaller quantity of coal used in 1935 cost as much as the larger quantity used in 1934 because the ton cost for 1935 was about 17 per cent more than for 1934.

[d]During 1934 all labor costs for operating were included in the general account of the company installing the system, and in 1935 they were charged to the engineer's department of the *Tribune*.

*Chicago Tribune Building Corp.

By **T. H. Rea***

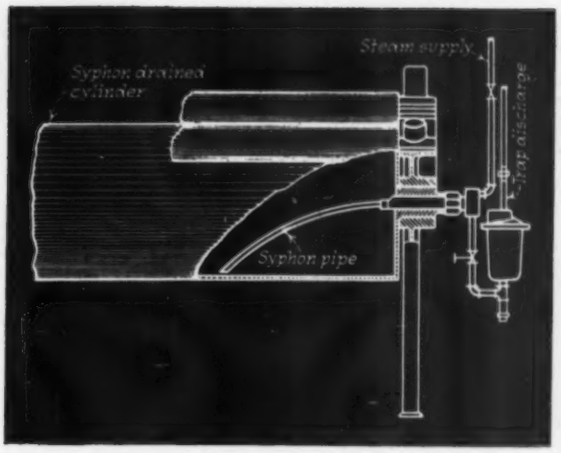
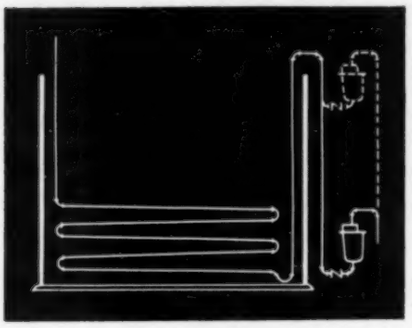


Fig. 1—In an installation of this kind, care must be taken to insure against leaks in the syphon pipe

Fig. 2—The trap may be placed in either of the positions shown on this type of installation. A dip in the coil just ahead of the vertical riser will prevent water from accumulating on the bottom of the coil



Draining Steam-Using Equipment

—practical pointers on trap installation and maintenance

"I WOULD like," writes a plant engineer reader, "some practical information on the installation and maintenance of steam traps for the drainage and collection of condensate from steam using equipment to avoid waste of water and time in starting up."

Assuming that the right type has been chosen for the job, even the best trap will not insure quick heating of process machines unless it is properly installed.

Wherever it is economically possible, the trap should be below and close to the unit being drained to insure gravity drainage of condensate to the trap, which is generally desirable. However, in some cases it is impossible to obtain gravity drainage, in others it is not practical. The use of a syphon then becomes necessary.

Steam heated revolving dryer drums, Fig. 1, are generally syphon drained. In making an installation of this type special care should be taken to insure against leaks in the syphon. With a leaky syphon pipe the trap cannot operate until the drum is half full of water.

Because of difficulty in maintaining tight joints in vats containing corrosive chemicals, it is common practice to pipe the condensate from heating coils up over the side of the tank instead of getting gravity drainage through the tank wall, as shown in Fig. 2. The trap may be installed in either of the two positions shown. A dip in the coil just ahead of the vertical riser will prevent water from accumulating on the bottom of the coil. A check valve between the trap and the coil will prevent back flow when the steam supply is shut off.

There is no hard and fast rule as to what constitutes a good trap installation. Obviously, what would be satisfactory for a radiator installation would hardly do for an important steam separator job. Perhaps the best way to cover the subject is to comment on the various fittings used to make trap installations.

Unions or flanged joints should always be used on the discharge side. Large traps on important drip jobs should have unions in both inlet and outlet lines to facilitate prompt trap replacement in an emergency.

Shut off valves of the gate or globe type should be installed in the inlet line to all traps with the possible exception of those draining small and relatively unimportant units from which the steam can be shut off in case work must be done on the trap. Shut off or check valves should be installed in the discharge lines.

Check valves should be put in the discharge lines as above noted, and also in the inlet line if the trap is above the unit being drained or if sudden pressure drops occur in the steam supply line.

Test cocks or *valves* should be installed on the discharge side of the traps between the trap and the check or shut off valve.

Strainers or *dirt pockets* are invaluable ahead of the traps where scale conditions are bad. Blowing the line down at full steam pressure before putting the trap in the line will save a lot of trouble from pipe cuttings, etc.

Bypasses should be used with discretion. Where continuous service is absolutely essential, as when traps are draining steam separators and purifiers, bypasses are necessary. On most heating and process units, bypasses can be omitted with worthwhile savings in steam consumption.

Inspect, Overhaul Traps Regularly

While it is not uncommon to hear of traps that have operated perfectly without attention for periods of five, ten and even fifteen years, the fact remains that, like any other automatic machine, a trap is entitled to regular inspection and an overhauling at least once a year.

[*Continued on next page*]

*Armstrong Machine Works, Three Rivers, Mich.

PRACTICAL HEATING

By **Harold J. Taylor***

Check Valves on Radiators If a check valve is installed on the level of the return opening of a radiator in a two-pipe steam heating system and the boiler is under pressure, little or no water of condensation will be held up in the radiator; but when the pressure drops near to zero the steam will continue to condense in the radiator and the condensate will pile up until it has sufficient weight or head to open the check. This will lower the water line in the boiler, and if a number of radiators are all holding a certain volume of condensate, the lowering of the water line in the boiler may be responsible for boiler breakage.

I have observed this condition on several installations in garages. The remedy is to remove the flaps from the valves, and the boiler water line will not be affected from this source of trouble under normal firing conditions.

If it is desired to install a check valve on the return of a radiator, the check valve should be placed at least 8 in. below the outlet of the radiator. This will allow sufficient head of water to open the check without it piling up in the radiator.

If the flaps are removed from the valves, then the closing of the radiator valves will not prevent steam from entering the radiator through the return end if the return line is of the dry return system. If the returns from the radiators connect to a wet return, then the flaps cannot be removed unless the radiator valves are to be left open at all times. In this case either the radiator valves should be removed, or the check valves should be installed at a lower level.

This type of hook-up applies on down-feed piping systems when the supply is either connected to the top or bottom radiator tapping. It applies only on up-feed piping systems when the supply is connected to top radiator tapping.

Dimensions for Blow Off Tanks For blowing off high pressure boilers, a blow off tank is installed between the boiler and the connecting sewer to prevent the escape of steam into the sewer. These tanks are usually made of cast iron, standard or extra heavy, and may be placed either above or below the ground.

Municipal requirements covering the installation of blow off tanks differ, but as a rule the following data will be helpful in the selection of tank size:

Pressure, lb per sq in.	Boiler horse power	Tank size, inches
1 to 10	1 to 10	16 x 20
11 to 15	11 to 25	18 x 24
16 to 25	11 to 25	24 x 30
16 to 25	26 to 50	24 x 36
26 to 50	26 to 50	30 x 36
26 to 50	51 to 75	30 x 60
51 to 75	76 to 100	36 x 48
76 to 100	101 to 125	42 x 60
101 to 125	126 to 150	42 x 72
126 to 150	151 to 200	48 x 72
151 to 200	201 to 300	60 x 60
201 to 300	301 to 400	60 x 72

*Contracting Engineer, Detroit, Mich.

On the above tank sizes the connections are 4 in. except on the 16x20 and 18x24 when the vent size is 3 in.

A code which I believe is very good and is used by one state, is as follows:

"The blow off pipe discharging into a tank shall have a free discharge at least 6 in. above the maximum water level. The discharge connection shall be at least 24 in. below the top of the tank and shall be trapped with a water seal at least 24 in. deep."

In this case the tank would have to be 54 in. long with a diameter of 36 in., since a smaller diameter is not allowed by the code.

Boiler horsepower	Tank size, inches	Outlet size, inches	Vent size, inches
1 to 100	36 x 54	5	4
101 to 150	36 x 54	5	5
151 to 250	36 x 60	5	5
251 to 600	42 x 60	5	6
Over 600	48 x 72	6	6

In referring to the data in the first table, it is advisable when using a tank of 54 in. or more to follow the above specifications, subject of course to the code in the particular location.

Draining Steam-Using Equipment—

[*Continued from preceding page*]

Through no particular fault of its own, a trap may lose its prime and blow through. The steam loss not only runs into real money, but a trap that blows through for a week will receive more wear and tear than during normal operation for one or two years. Hence, it should be obvious that a thorough check-up of trap operation should result not only in steam savings, but also in reduced maintenance expense.

In some plants, traps are checked daily, others weekly and, in all too many cases, never. In order to facilitate daily or even weekly inspection, all traps should have a test cock and furthermore should be installed in a location easily accessible to the inspector.

Ordinarily but a few moments are required to check the operation of a steam trap. With the test cock open the intermittent or semi-continuous discharge of a properly functioning trap is readily apparent and nothing more need be done. On the other hand, if the trap is blowing live steam (which must not be confused with "flash" from the discharged condensate) shut the inlet valve for a few minutes. Then open the valve slowly to give the trap a chance to prime itself. If the trap starts to work properly, the chances are that a piece of dirt caused the trap to lose its prime. If the trap again blows through, it should be examined for mechanical defects such as worn valve parts, broken pivots, etc.

If the trap refuses to open, the pressure may be too high due to faulty regulating valves, increase in steam pressure or increase in the vacuum in the return line. Or possibly the condensate is escaping through a leaky bypass valve located below the trap.

Under favorable conditions a man can inspect several hundred traps per day. The resulting savings in steam consumption and repair parts represent a handsome return on the labor cost.

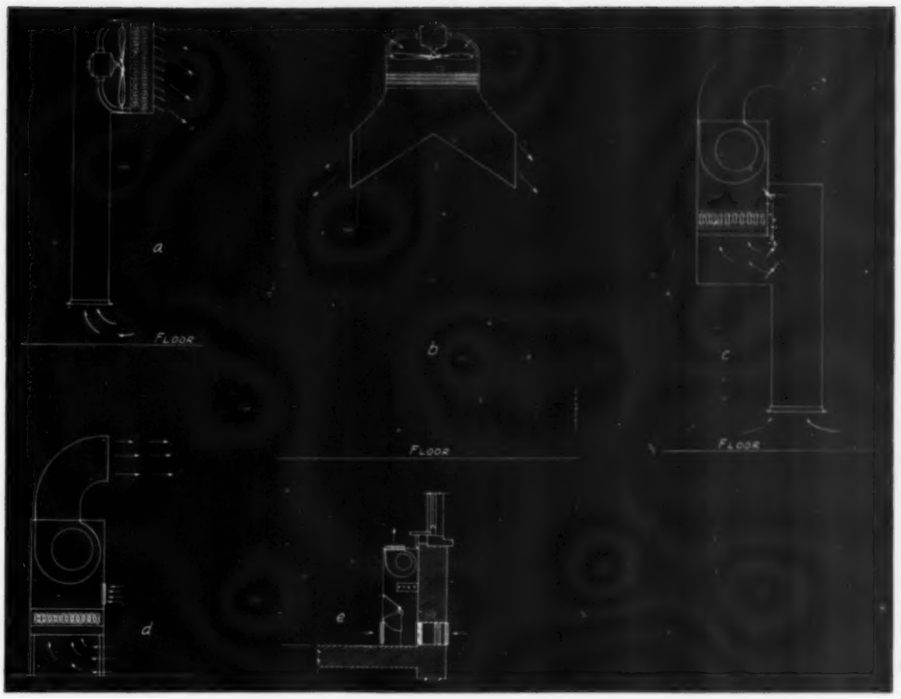
Sketch a—Suspended type unit, generally mounted 10 to 15 ft above floor

Sketch b—Suspended type unit, generally mounted near ceiling, or not over 20 ft above floor

Sketch c—Floor or cabinet type of unit suspended above the floor

Sketch d—Cabinet or floor type unit mounted on floor

Sketch e—Unit with outdoor air connection used where ventilation is required



Types *of* Unit Heaters *for* Industrial Use

By **Perry West***

SUPPLEMENTING the information on estimating load, selection, location, control and piping for industrial unit heaters published in the September H. P. & A. C., pp. 419-422, the various types of plant heating units are briefly described this month.

Broadly speaking, there are four general types of unit heaters—steam or water heated type, gas heated type, electric, and direct oil or solid fuel fired heaters. These are again sub-divided into the floor mounted and the suspended models of most of these types. Substantially all types and models employ some form of extended heating surface over which air is blown or drawn with a fan or fans. Most of the air is usually recirculated, but in some cases a small part is taken in from out-of-doors, while in rare cases all of the air is from the outside.

Suspended units usually take air in from their own height above the floor and discharge it out and downward toward or along the exposed walls and toward the floor of the spaces to be heated. In some cases such units are provided with inlet sheet metal ducts for taking the air from near the floor. The floor mounted units usually take air from near the floor and discharge it horizontally at a height sufficiently above the heads of occupants or above machinery to prevent objectionable drafts or interference with the proper distribution of the heated air. They may be suspended either in a vertical or a horizontal position with the inlet air entering from a height above the floor corresponding to the bottom of the unit, or through an inlet duct extending to a point near the floor, and discharging the air either horizontally or outward and down as with the regular suspended types of units.

Because these so-called floor types of units may be, and are, frequently suspended in one position or another, perhaps a better sub-division for the two different kinds of units would be the *cabinet type* and the *radiator type*, the cabinet type corresponding to what has been known as the floor mounted type and the radiator type to what has been known as the suspended type.

Sketches *a, b, c* and *d* represent the more common types of unit heaters. Sketch *a* represents a radiator or suspended type, consisting of a vertical extended surface radiator with an electric motor driven disc type fan back of the radiator and adjustable louvers in front. This type of unit is generally mounted from 10 to 15 ft above the floor and may be provided with an inlet duct as shown for taking air from a point near the floor. The warm air is directed out and downward to the floor and returns upward toward the fan inlet.

Another type of radiator or suspended type unit with the extended surface radiator mounted horizontally, with the electric motor driven fan above the radiator and adjustable discharge ducts below, is shown by sketch *b*. This type of unit is generally mounted near the ceiling, or in extremely high buildings not over about 20 ft above the floor, and is so spaced and adjusted as to force the blanket of warm air down over the entire floor area. This type of unit takes air from overhead and, if placed in monitors or near skylights with ventilators, may draw

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Crane Operators Cooled

Cooling instead of heating is required to keep the operators of the hot metal and decanting cranes at the A. M. Byers plant comfortable as rapidity of the cycle of operations confines them to their cabs without spell periods in more tolerable atmospheres; during summer months radiant heat from the molten metal and the slag formerly raised the cab temperature to 120 degrees.

Consequently, cooling units operated by ⅓ hp motors at 230 volts were mounted on the tops of the cabs to maintain the temperature at 70-75 F.

Cool air inlet is in the corner farthest from the operator, return outlet in the near corner. Entire sides and floors of cabs are insulated with 1⅛ in. asbestos sheathing. The cooling units measure 15 in. wide, 16 in. high, and 14 in. deep including condensers.

air in from outdoors. Its usual air circuit, however, is to drive the warm air down to the floor where it mushrooms out and rises back up to the inlet of the fan.

Sketch *c* represents a floor or cabinet type of unit suspended above the floor at about the same height as the other units referred to above. This type consists of a cabinet with a centrifugal housed blower or blowers in the top of the cabinet and an extended surface radiator set horizontally below the fan or fans. The air is drawn in through a grille below the radiator and is discharged outward and downward through cowls attached to the discharge of the fans. This type of unit is sometimes provided with a second inlet above the radiator, whereby the entering air may be either passed through or around the radiator, depending upon the heating requirements. This latter arrangement is useful for controlling the temperature of a space automatically while allowing the air to be recirculated at all times whether heat is required or not. This unit may be fitted with intake ducts for taking the air from near the floor and with a bypass duct arrangement where such a unit is employed.

Sketch *d* represents the cabinet or floor unit actually mounted on the floor. The unit itself is the same as represented in *c*.

Gas fired units are not illustrated, but may be of most any of the types just described, the only difference being that the heating is done by a gas heated radiator. The temperature control is different as has been explained. They have some advantages in low first cost and in not requiring any boiler or steam or water piping, although they do require gas piping. The direct oil or solid fuel fired unit heaters are used to some extent as they have some advantages of low cost and do not require boiler or piping.

All electric unit heaters of the various types described are available; their application is generally to meet special requirements in heating only a certain area of a plant when the main heating plant is shut down, where the convenience of electricity as a fuel is desirable, where the electrical rate is quite low, etc.

Any of the above types may be arranged to take either a part or all of their air supply from outdoors, but are usually installed so as to recirculate all of the air from within the building. Where outdoor air is required for ventilation the type of unit shown by sketch *e* is generally used. It has a fresh air inlet usually equipped with a grille and stormproof louvers and, just inside of these, an air filter. There is also a recirculation air opening from the room with a grille. Between these two air intake openings there is usually a switch damper for closing, either opening and taking the air from the other, or for intermediate adjustments, so that air can be taken from both openings at once in various relative proportions. Some of these dampers are hand operated, while others are automatically operated and thermostatically controlled, so as to hold the outside fresh air intake closed until the room is heated to its normal temperature and then to control the mixture of the fresh air from the outside and the recirculated air from the inside, so as to preserve a constant minimum temperature of the mixture, and thus prevent the air leaving the unit from ever falling to a temperature that would cause objectionable drafts.

After passing through the intakes the air goes to the fan or fans and is then discharged either through or around a fin type heater, with a bypass damper, so arranged as to control this flow of the air. This bypass damper is usually thermostatically controlled from the temperature of the room and may be arranged to maintain a minimum temperature of the air leaving the unit for preventing cold drafts. Where the mixture of outside and recirculated air is so controlled as to maintain a minimum temperature of the mixture this latter control of the bypass damper for this purpose is not required.

Some units of this type have a second radiator with thermostatic control for the first radiator from a thermostat in the air stream just ahead of the second radiator for preserving the minimum temperature of the air stream and a second thermostat in the room for controlling the second radiator according to the heating requirements.

Where the mixture of outside and inside air is controlled to maintain a minimum temperature the second radiator is not required. This type of unit generally sets on the floor and discharges the air up and slightly outward, usually against the ceiling, where it mushrooms out and rebounds over the entire room. It may be so designed and arranged to mount horizontally on the ceiling and discharge the air overhead or downward.

Where other "air conditioning" (such as humidifying, dehumidifying, cooling, ozonizing or ionizing) is required in addition to heating, air cleaning, and air circulation, most any of the types of units already referred to can be had with the necessary attachments and appurtenances for accomplishing any or all of these results.

Comfort Zone *is not always the* Health Zone

In layman's language Dr. Arnold describes the skin's function in the control of body temperature, tells why the comfort zone is not always the health zone..... The author, for many years a research worker in this field, believes that further studies on proper temperatures, humidities, and air motions in conditioned spaces are needed.....The question of the proper conditions to maintain is highly important on every job, for (as John Howatt said in his president's message to A.S.H.V.E. members last month) the performance of an air conditioning system as measured by the occupants must always provide maximum comfort, no matter what the technique of obtaining those conditions

[*By* Lloyd Arnold, M.D.*]

WHEN Mark Twain said, regarding a hot day, "I feel like taking off my skin and sitting around in my bones" he got a laugh, but showed he didn't know what a blessing the skin is. If he had sat around in his bones on a 103-degree-in-the-shade day, the temperature of his bones would have been 103 F. It was the "refrigerator power" of his skin that made it possible for his body temperature to be more than 4 F lower than the air temperature, just as it is the "radiator power" of our skins that makes it possible for us to maintain 98.8 F body temperature when the air is much colder.

As a research worker who has spent many years studying the function of the human skin the author feels that air conditioning engineers, in their establishment of the factors that make what is called the *comfort zone* have not taken into sufficient consideration the complexity of the human skin's own air conditioning function. As air conditioning is practiced now, there are many days in which the *comfort zone* is not the *health zone.*

On cool summer days the comfort zone and the health zone probably approximate each other. It is then a delightful sensation to sit in an air conditioned room or train. But when the outside temperature is in the upper nineties and the inside temperature in the lower seventies the reaction is not so good. It is common for patients to complain that their head colds were due to sitting in a 70 F room on a hot day. And just about every one of us coming out of a 70 F room into a 90 F plus outside temperature experiences a feeling of suffocation or of dizziness. There are too frequent instances of individuals collapsing completely. And far too many persons have intestinal upsets, even to the point of vomiting.

Harmful Effects of Sudden Temperature Changes

Why is this? It is because the change is too sudden. The body is given scarcely a second's time to prepare for it. In Nature there are no such changes of temperature, except in the rare instances of a severe barometric drop. Between winter and summer there are the slowly warming spring months; between summer and winter the slowly cooling fall months. And in any single day the 24 hour temperature range is not often more than 30 F, and a 5 F rise or drop in one hour is quite unusual. Artificial cooling asks us to make a 20 to 30 F change in the time it takes us to step from one room into another. Is it any wonder that the body rebels?

Some one may say that in winter we are accustomed to stepping from a 70 F room into 20 F below zero outside temperature, a change of 90 F. But we then have our bodies insulated with warm clothes. There is only a small area of our face skin exposed, and the nose has a specialized arrangement of capillaries by which the blood, at the first exposure to cold, instantly leaves the nose, so that there is a drop in nose temperature; then, in the space of a few moments' time, it returns with a rush, and for a short space the nose temperature is above normal or at fever heat. Within ten minutes in a healthy person, it settles back to normal, and the body has adjusted itself to the change. The low humidity prevailing in cold weather is also an important factor in the body's adjustment. If a person's nose has not quick adjusting ability, however, then the cold viruses, which are always present in the nose, can get in their work, and the result is that the individual catches a cold.

But the entire skin surface of the human body has a "radiator function" that is peculiar, of all animals, to it alone. Other animals depend upon their fur for insulation against cold, and if it isn't thick enough for extreme cold, they hibernate in a warm place. Man, how-

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ever, with his skin $\frac{1}{25}$ in. thick, has been given by Nature a unique arrangement of skin blood vessels. Instead of the blood vessels lying flat in branch-like formation on the inside structure of the skin as they do in other animals, man's capillaries are curved in a myriad arrangement of X-forms and horseshoe bends, so that the blood can shift from the inner organs to the outside skin and *vice versa* in a second's time. When the outside air is cold, the blood leaves the skin to conserve the body heat; when the air is warm, it comes to the surface to give off body heat.

But in addition to this giving off of heat by radiation, the human body has another unique mechanism for cooling, the simple sweat glands. We have millions of these glands scattered all over our bodies to give off heat by evaporation; animals have these peculiar glands only in the tips of their noses and in the skin between their toes; dogs and other animals that pant have them also on their tongues.

Now what happens when we go into a 70 F room from an outside temperature in the nineties? Before we step into the room we are, of course, hot. Our skin blood vessels are dilated, trying to give of what little heat they can, and our "refrigerator system" is working full blast with all the sweat glands oozing off sweat. Our clothes are as thin and as few as the law allows, and damp to boot. We probably do not have an extra wrap with us. We cross the threshhold, and immediately our sweat glands discover that they can stop working, and the blood in our capillaries discovers it must leave the skin so as to conserve heat. Our *feeling,* however, is one of grateful comfort.

But at the end of ten minutes the feeling is not so good. If we have a coat we put it on; if not, we remain uncomfortable. If the machinery of our nose temperature reaction is in good order, we don't get a cold; but if it isn't we get the start of a bad one. Finally, it is time for us to leave. We step out into 90 F heat again. Instantaneously and without the least warning our millions of sweat glands are called upon to function and our skin blood vessels are filled with blood, leaving the digestive organs and the lung tissue blanched. Is it any wonder that we feel suffocated and dizzy and nauseated or that those of us possessing the least adaptable functions collapse entirely?

The medical profession regards air conditioning as a most helpful instrument in the maintenance of health. At Harvard's school of public health, successful chartings for proper air conditioning in operating rooms, oxygen chambers and incubator baby rooms have been worked out, and both there and at the University of Illinois very encouraging work has been done in the conditioning of air for hay fever and asthmatic patients. But before further work in conditioning air for the sick is done, I believe that intensive research should be undertaken to determine what constitutes proper air conditioning for normal, healthy persons under all weather variations. According to medical opinion both in this country and abroad the difference between inside and outside temperature on a hot day should not be more than 10 F, possibly less, and the inside humidity should probably be between 40 and 50 per cent, with the air velocity an important factor. The idea, in other words, would be to give us *shade* temperature with comfortable humidity and air velocity. Still air at 90 F and 90 per cent relative humidity is almost unbearable. But with a slightly lowered temperature and the other factors controlled, the body could adjust itself without harmful strain.

Tribune Tower—

(*Continued from page* 484)

arrangement exclusively for the air conditioning system, without diversion for any other building service.

The *Tribune* is more than satisfied with its experience. Air conditioning has contributed to its employees' comfort, has made it possible for them to do more work, has cut down on absences due to illness.

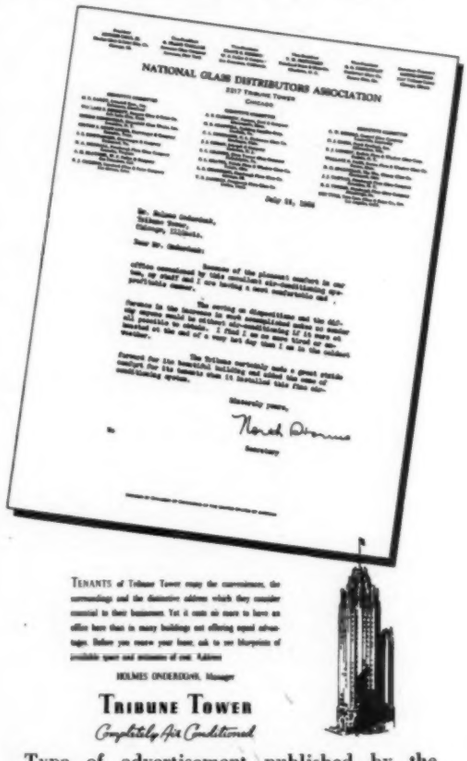
It has been directly responsible for the signing of a number of leases. The office building situation is not normal at this time in Chicago, existing capacity being far beyond existing needs. Air conditioning has helped the Tribune Tower maintain an 80 per cent occupancy against an average of about 70 per cent for the city. It has given the Tribune Tower preference where rents are equal with those of other first class buildings without air conditioning. It has been one of the modern services which have attracted desirable tenants, maintained the building's reputation of leadership and quality, made the Tribune Tower address a business asset to firms renting space in it.

With the return of more normal conditions the *Tribune* is confident that air conditioning will even more tangibly support its theory that the right tenants will pay for service . . . that profits in office building operation do not come from cutting expenses but from increasing services.

Holmes Onderdonk, manager of the Tribune Tower, remembers the time when office building owners thought it was unnecessary expense to supply hot water for their tenants. They could wash their hands in cold water. Why double the plumbing expense?

Into the same discard must go any similar attitude toward air conditioning. As Mr. Onderdonk puts it, "Once a thing becomes a commercial possibility, it becomes a necessity." Air conditioning, the *Tribune* feels, is in that classification.

. . . the acme of comfort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President, L. B. PITTOCK
429-B Oliver Bldg.
Secretary, T. F. ROCKWELL
Carnegie Inst. Tech.

ST. LOUIS
Headquarters, St. Louis
Meets: First Wednesday in Month
President, J. W. COOPER
1596 Arcade Bldg.
Secretary, A. L. WALTERS
7284 Richmond Pl.,
Maplewood, Mo.

SOUTHERN CALIFORNIA
Headquarters, Los Angeles
Meets: Second Tuesday in Month
President, W. E. BARNUM
5051 Santa Fe Ave.
Secretary, P. C. SCOFIELD
748 E. Washington Blvd.

WISCONSIN
Headquarters, Milwaukee
Meets: Third Monday in Month
President, C. H. RANDOLPH
1925 N. Prospect Ave.
Secretary, R. G. KOCH
626 E. Wisconsin Ave.

Chemical Dehydration of Air

By **H. J. Kaufman*** ***(NON-MEMBER)***

Detroit, Mich.

AIR conditioning has become a much used and also a much abused topic of conversation, not only by the public, but also by others who are more or less connected with the industry itself. If air conditioning for human comfort is to come into universal use, as expressed by optimistic writers, and ideal climatic conditions are to be maintained within enclosures by artificial means, it will require the practical application of the term in its fullest meaning, and in addition, the understanding of some other factors which are not clearly known or in common use at present.

The damp and uncomfortable air in many theaters, stores, and offices, the necessary replenishment of the air from an exterior source, the after effects of exposure to some air conditioning installations, and the complaints from the public indicate that something more than merely removing heat or moisture from an enclosure is required to produce ideal comfort conditions. An ideal air conditioning system would be one which corrected uncomfortable atmospheric conditions and also the effect of apparatus and occupants on the air of an enclosure, and which is considerably beyond the range of ordinary present day apparatus.

Air is a mechanical mixture of gases, vapors, colloids, solids, etc., and the changing of these proportions has been largely accomplished by mechanical means and the effects have also been of a mechanical nature, in which heat and moisture have been removed in one combined operation and in which moisture removal is dependent upon heat removal whether required or not. Air conditioning, as it is known today, has been largely developed by heating, ventilating, and refrigerating engineers because of their contact with the building industry, and the principles in general use are common to these branches of engineering.

Some of the changes in the properties of air can be more economically performed by chemical action than by mechanical action, other changes can be accomplished by chemical means that are not practical to accomplish by mechanical means, and still other changes can be more effectively performed by a combination of mechanical and chemical means. While the changes in the temperature or humidity of the air may be accomplished by mechanical apparatus and may be termed mechanical changes, the changes in the proportions of the gases and vapors are chemical changes and require a study of chemistry rather than of mechanics. These chemical principles have not been extensively applied to air conditioning because of the absence of a practical connection between chemical engineers and the building industry such as exists in the other branches of engineering, as already mentioned. When more thought and analysis is applied to the characteristics of air and the changes necessary to produce ideal climatic conditions within occupied enclosures, then chemical engineering should become an important part of air conditioning.

When conditioning air for human comfort, the minor portion of the air supply is taken from out-of-doors and the principal corrections to be made are those of temperature, humidity, and removal of solids which can be done with mechanical equipment, while the major portion of the air supply is taken from indoors and requires extensive treatment to offset the changes made by respiration and by contact with the human body in order to resemble fresh air in effect. While some of these changes are known, others are not definitely defined or in practical use at present. Oxygen has long been known as essential to human life and its proportion should be increased in the recirculated air to maintain the proper proportion in the supply air. Carbon dioxide until recent years was considered harmful but it is now used as a guide inversely to measure good air conditions and should be kept at a low percentage to insure comfort conditions. The respired air from the lungs of a human body has approximately one hundred times as much carbon dioxide as normal fresh air.

Ionization, or the electrical phase of air, has been considered a factor in air conditioning since 1926 and is associated with the freshness of air. The number of positive and negative small ions is considerably less in the air of occupied spaces than in normal fresh air and it is believed that the presence of these electrified particles has something to do with the freshness of air. The unknown factors may be vapors, colloids or solids, of unknown properties.

As the air of occupied spaces is affected by the occupants and by apparatus in use, it is also affected by the mechanical equipment of the air conditioning system, which in order to accomplish one or more purposes may produce some undesirable effects. It has been stated, as a chemical principle, that contacting air with a spray of water removes more oxygen than nitrogen, thereby decreasing the oxygen content of the air. Research has shown that small ions are removed from the air by contacting it with cold metal surfaces. It is believed that they are also removed by contacting the air with cold wet surfaces or water in contact with the metal surfaces as in the case of mechanical condensation.

Considerable improvement can be made in air conditioning for comfort purposes by using mechanical apparatus to perform mechanical operations such as removing heat and solids from the air and by using chemical apparatus to perform chemical operations such as removing moisture, carbon dioxide, vapors, and colloids from the air, and increasing the ion content.

Air can be dehydrated by chemical action throughout the range of temperature in which human life exists, in an individual operation without lowering the temperature, in connection with cooling, or in connection with heating. Certain soluble vapors such as carbon dioxide are also removed. Colloids and smoke particles are removed by removing the water vapor in connec-

*Consulting Engr.

tion therewith and by contacting the air with adhesive surfaces. This action is also true of pollens and dust particles to which germs and microbes are attached. It is believed that the oxygen content of the air is increased due to a slight production of ozone. It is also believed that the ion content is increased due to the conversion of latent heat into sensible heat by hygroscopic action. Considerable energy is connected with this operation of converting heat into another form. Static electricity is associated with dry air, and ionization is associated with heat, energy, and static electricity.

Aside from the lower initial and operating costs of chemical dehydration compared to mechanical dehydration apparatus, and the comparative simplicity of the same, there are mechanical advantages due to separating dehydration and cooling into two distinct steps. This allows individual control of each step and makes a more flexible and economical system by varying each operation for varying occupancy or atmospheric condition, as will be more clearly illustrated by the accompanying diagrams which are drawn on a Grosvenor chart.

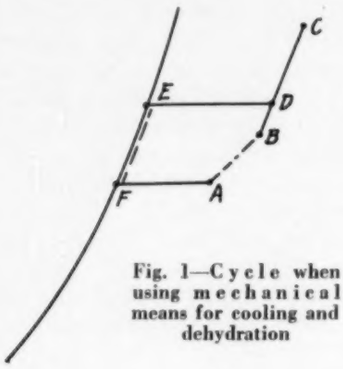


Fig. 1—Cycle when using mechanical means for cooling and dehydration

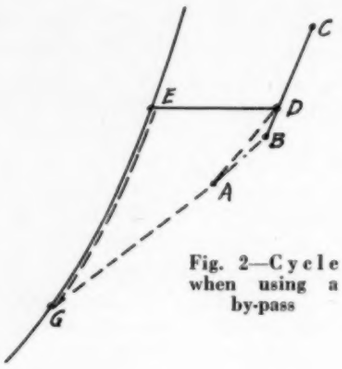


Fig. 2—Cycle when using a by-pass

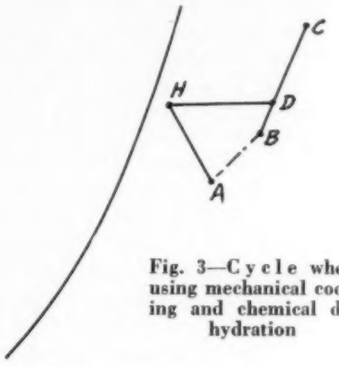


Fig. 3—Cycle when using mechanical cooling and chemical dehydration

Fig. 1 shows the cycle of operations when using mechanical means for cooling and dehydration with heat applied to increase the temperature of the dehydrated air up to room condition. Fig. 2 shows the cycle when using a bypass and mixing cold dehydrated air with warm recirculated air to increase the temperature of the dehydrated air up to room condition. Fig. 3 shows the cycle when using mechanical cooling and chemical dehydration. Fig. 4 shows the cycle when using mechanical pre-cooling, chemical dehydration, and mechanical after-cooling. Fig. 5 shows the cycle when using chemical dehydration and mechanical cooling.

By referring to Fig. 1 and assuming that the air entering a theater or other similarly occupied enclosure as having a temperature of 74 deg and a relative humidity of 50 per cent and denoted on the chart as point *A*, the air leaving the enclosure having a temperature of 85 deg and a relative humidity of 40 per cent by the point *B*, 25 per cent of this leaving air is wasted out-of-doors and the remaining 75 per cent is mixed with fresh air in the same amount as that of the air wasted. This fresh air having a temperature of 95 deg and a relative humidity of 40 per cent and indicated by the point *C* is mixed with the recirculated air to form a mixture having a temperature of 87 deg and a relative humidity of 40 per cent and indicated by the point *D*, is sensibly cooled to the saturation point *E*, then mechanically cooled and dehydrated to the point *F*, and then reheated to bring it up to the entering air condition represented by the point *A*; cooling and dehydrating being performed in one operation.

Fig. 2 shows the advantages of using the bypass method in which a portion of the mixture *D* is sensibly cooled to saturation temperature at the point *E*, then mechanically cooled and dehydrated to the point *G*, and then mixed with the remainder of the mixture *D* to bring it up to the entering air condition at the point *A*. This is an improvement over the first example in efficiency and in regulation. Cooling and dehydrating are performed by the same operation and are dependent upon each other.

Fig. 3 shows the mixture *D* sensibly cooled to the point *H*, which has the same wet bulb temperature as the point *A*, and then chemically dehydrated along this wet bulb line to the point *A*, the amount of heat and moisture removal being performed in two distinct operations and controlled individually.

Fig. 4 shows the chemical dehydration step being continued to the point *J* and further cooled to the point *K*. The lengths of the lines *DH*, *HJ*, and *JK* can be varied independently of each other and the point *A* can be moved to the point *K* and still be brought into the room at the same temperature.

Fig. 5 shows the mixture *D* being chemically dehydrated to the point *L* and then cooled to the point *A*. The dotted lines indicate the possibility of chemically dehydrating the air to the point *M* and then cooling to the point *N*. The lengths of the lines *DL*, *DM*, *LA* and *MN* can also be varied independently of each other.

With chemical dehydration as a part of air conditioning for human comfort, the tendency is toward higher temperatures and lower relative humidities and depending upon evaporation from the body rather than upon cooling for comfort. This reduces the amount of heat transmission through the walls and other parts of the enclosure, reduces the temperature differential between the outside and inside, eliminates the shock to the human system caused by going from a room of low temperature and high humidity to another space of high temperature, and allows the use of a higher temperature cooling medium. It is believed that with improved air conditions, and with relative humidities of 40 per cent, the temperature of occupied spaces can be higher than present comfort charts indicate.

There are many applications for a system of air conditioning in which the various steps can be operated separately at any season of the year and in which a com-

paratively high temperature cooling means can be used, such as well or tap water. Surface cooling eliminated dew point temperature as a factor in cooling means. Chemical dehydration also eliminates dew point temperature as a potential factor in dehydration. There are many applications in which dehydration is required in drying or evaporating processes at subnormal, normal, abnormal, or variable temperatures with fresh or recirculated air supply. There are many applications in which dehydration is the only factor, such as preventing condensation in unheated rooms for the protection of electrical or mechanical apparatus, the storage of sugar, potatoes, onions, or other products which may be affected by moisture in the air, and many special uses, such as hospital operating rooms and the like.

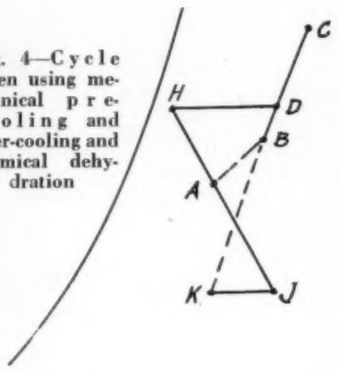


Fig. 4—Cycle when using mechanical precooling and after-cooling and chemical dehydration

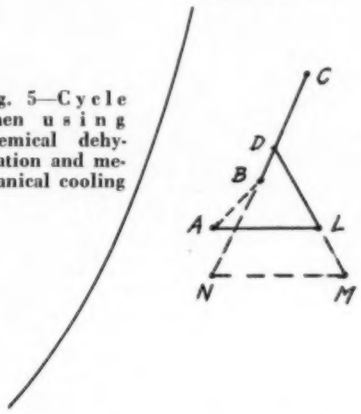


Fig. 5—Cycle when using chemical dehydration and mechanical cooling

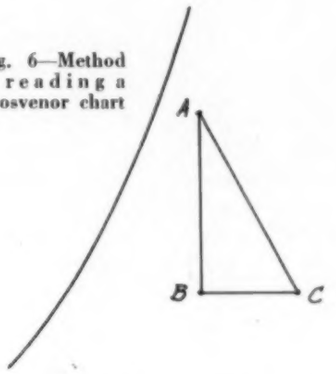


Fig. 6—Method of reading a Grosvenor chart

Fig. 6 illustrates the method of reading a Grosvenor chart, in which the line *AB* represents constant temperature, the line *AC* constant total heat, and the line *BC* constant absolute humidity of the air.

In order properly to appraise these different methods of conditioning air with regard to the commercial saving to the owner of the building and to the tenant who pays for the operation of the system it is necessary to compare them on the same basis, and for this purpose the figures obtained this season for a small theater in a suburb of Detroit might be interesting for analysis.

The theater has a seating capacity for 600 occupants, a ventilating system which is designed for 12,000 cfm, and a test well indicated a supply of cooling water of 120 gal per minute with a temperature of 52 deg in the well, which is common for this vicinity. The building is situated in the center of a block and none of the walls of the auditorium are exposed to outside air. The auditorium has a flat roof which is covered with tar and gravel and it was intended to waste the condenser or cooling water at the high point of the roof in order to reduce the cooling load, which is calculated at approximately 30 tons of refrigeration.

The example is based upon a total air supply of 15,000 cfm, a latent heat load of 153,500 Btu per hour, and a sensible heat load of 206,500 Btu per hr. The air entering the room has a temperature of 74 deg and a relative humidity of 50 per cent and is represented by the point *A*. The air leaving the room has a temperature of 85 deg and a relative humidity of 40 per cent and is represented by the point *B*. 11,250 cfm of recirculated air is mixed with 3,750 cfm of fresh air having a dry bulb temperature of 95 deg and a wet bulb temperature of 75 deg and produces a mixture having a temperature of 87 deg and a relative humidity of 40 per cent. The fresh air is represented by the point *C* and the mixture is represented by the point *D*.

Referring to Fig. 1, the mixture *D* is cooled to saturation at 60 deg temperature represented by the point *E*, then further cooled along the saturation line to 54 deg temperature represented by the point *F*, and then heated to complete the cycle at the point *A*. This method requires the removal of 683,000 Btu per hr and the replacement of 323,000 Btu per hr. The evaporator temperature is based upon 40 deg.

Referring to Fig. 2, a minor portion of the mixture *D* is cooled to saturation at the point *E*, then along the saturation line to 40 deg temperature represented by the point *G*, and then mixed with the remainder of the air at the point *D*. If a sufficient amount of the mixture *D* is cooled to the point *G* the final mixture will have a temperature below that of the point *A* and if an amount is cooled to reduce the temperature of the final mixture to that of the point *A*, then the moisture content will be above that at the point *A* and the result will be a compromise between cooling and dehumidifying in which dehumidifying capacity is often sacrificed for cooling capacity. This method utilizes the heat in the bypassed air and reduces the amount of refrigeration in a large degree over that required in Fig. 1. The evaporator temperature is based upon 30 deg and the same amount of surface as used in the first method.

Referring to Fig. 3, the mixture *D* is sensibly cooled to a temperature of 65.5 deg and a wet bulb temperature of 62 deg and represented by the point *H*, this wet bulb temperature being the same as that of the point *A* and represented by the line *HA*. The wet bulb temperature of the point D is 69.5 deg and the length of the line *DH*, or the difference between the wet bulb temperatures of 69.5 and 62 deg, represents the amount of total heat removed. The dew point temperature of the air at the points *D* and *H* is 60 deg. The dew point temperature of the air at the point *A* is 54 deg. The difference between the dew point temperatures of the points *H* and *A* represents the amount of dehydration as represented by the length of the line *HA*. It is noted that these two steps or the lengths of the two lines *DH* and *HA* are separate steps and controlled individually. As compared to Fig. 1, the travel from *H* to *E* to *F* to *A* has been shortened to *HA*. The same amount of coil surface can be used as in the two previously described methods if the coils are supplied from a well with a water temperature of 52 deg and at the rate of 120 gpm which allows for a temperature rise of 6 deg and an average coil temperature of 55 deg.

Referring to Fig. 4, the line *HA* can be extended to a temperature of 87 deg and a dew point temperature of 42 deg as represented by the point *J* and this air cooled to 74 deg temperature along the line *JK*. The wet bulb temperature of the point *K* is 57 deg and this cooling can be done with the waste water from the first step. The extra amount of dehydration is represented by the difference between the dew point temperatures 54 and 42, and the extra amount of cooling is represented by the difference between the wet bulb temperatures 62 and 57 deg.

Referring to Fig. 5, the mixture *D* is dehydrated along the wet bulb line of 69.5 deg temperature and represented by the line *DL* to the dew point temperature of 54 deg represented by the point *L*, then sensibly cooled to the point *A*, the amount of dehydration being represented by the difference between the dew point temperatures of 60 and 54 deg represented by the points *D* and *L*, and the amount of cooling by the difference between the wet bulb temperatures 69.5 and 62 deg represented by the points *L* and *A*. The dehydrating and cooling steps are separated and each is controlled individually as in Figs. 3 and 4. This work being done in the higher temperatures allows the use of a higher temperature cooling medium and the same amount of water at the same temperature rise and with the same amount of coil surface would allow a temperature of 60 deg in the well to produce the same results. The dotted lines *LM* and *MN* indicate the possibility of extra dehydration and cooling, in which the dew point temperature of the air can be further lowered from 54 to 49.5 deg as indicated by the point *M* and the wet bulb temperature further lowered from 62 to 60 deg as indicated by the point *N*.

In comparing the costs of the methods, the method shown in Fig. 1 should be omitted because of the large amount of refrigeration required and the low thermal efficiency, and comparison made between the methods shown in Figs. 3 and 2. The cost of the cooling coil can be omitted from the computations because it is the same in both cases. Filtering is not included in Fig. 2, but is included as a part of the process in Fig. 3.

Referring to Fig. 2 and assuming that the refrigeration condenser is supplied with city water having a maximum temperature of 75 deg, the refrigerating equipment should have a capacity of 30 tons of refrigerating effect with an evaporator temperature of 30 deg and a condenser temperature of 90 deg. The cost of this equipment with bypass and controls is assumed at $4,500. The cost of the power for operating the equipment is assumed at 25 kw-hr at 3 cents per unit or $0.75 per hr. The cost of the condenser water at the rate of 7200 gal per hr is assumed at $0.60 per hr. The interest on the investment at 6 per cent and the depreciation at 10 per cent for 800 hrs of operation per season amounts to $0.90 per hr and which are fixed charges. The power and water costs are fixed for each hour of operation regardless of atmospheric conditions or the number of seats occupied. The total cost per hour amounts to $2.25 per operating hour.

Referring to Fig. 3 and assuming that the well and pump cost $850 and the dehydrating apparatus and controls cost $1,000, the total cost would be $1,850. The cost for operating the pump is assumed at 4 kw-hr at 3 cents per unit or $0.12 per hr, maximum cost for extreme temperature outside and with all seats occupied. There would be some saving on cool days and when the seats are partly filled. The cost of the dehydrating chemical can be assumed at $0.64 per hr for a maximum condition of high humidity outside and with all seats occupied. This cost would reduce to none at all with an empty house and a dry atmospheric condition. The maximum total cost per hour would be $1.13, including the fixed charges of $0.37 per hr, which are figured on the same basis as in the previous example. The average cost for the season would be between that for the maximum cost and that for the fixed charges or possibly $0.75 per hr.

There is an efficient filtering process in connection with some methods of chemical dehydration, which may be partly chemical and partly mechanical, in which various vapors, solids, colloids, and combinations of the same are attracted to the hygroscopic agent along with the water vapor which is absorbed from the air. This feature should be noted when appraising the values of the above described methods of conditioning air.

The above data are general in character and should apply to any method or apparatus which uses comparatively cheap hygroscopic material efficiently for dehydrating air and which wastes the solution after it has absorbed the maximum amount of water from the air.

It is possible to reduce the operating cost of the method of chemically dehydrating air by recovering and re-using the hygroscopic material. Low pressure steam from the heating system can be used for releasing the vapor from the solution and waste water from the cooling system can be used for restoring the material to normal air temperature. The effect on the air would be the same but the apparatus would be more complicated with higher fixed charges.

St. Louis

September 11, 1935. The first fall meeting of the St. Louis Chapter was held at Garavelli's with 26 members and guests present. The minutes of the May meeting were approved and the secretary, A. L. Walters, read several communications.

The matter of holding an Annual Meeting of the Society in St. Louis was again discussed and it was determined that the Chapter should endeavor to have the January 1937 meeting in St. Louis, as a joint meeting with the *A.S.R.E.*

After discussion it was moved and seconded that the Chair appoint a committee to consider amendments to the Chapter Constitution and By-Laws relating to the date of election of officers and the length of their term. The following were appointed to serve on this committee and report at the next meeting: R. J. Tenkonohy, *Chairman*, L. W. Moon, E. A. White, Paul Sodemann, and J. M. Foster.

E. E. Carlson gave the report of the treasurer.

As chairman of the Entertainment Committee, Mr. Carlson reported on the June party, which was enjoyed by the 90 members and guests who attended.

In the absence of G. W. F. Myers, chairman of the Program Committee, Pres. J. W. Cooper introduced J. E. Manahan, who gave a very interesting illustrated talk on Installing a Modern Air Conditioning System in a Modern Restaurant. The discussion described the installation in the building where the meeting was held. After a rising vote of thanks to the speaker, the meeting adjourned and an inspection of the installation and equipment was made by those present.

Using the Reversed Cycle Refrigerating Principle for a Self-Contained Heating and Cooling Unit

By **Henry L. Galson*** ***(NON-MEMBER)***

Philadelphia, Pa.

HEATING as a by-product of refrigeration is not a new development for Lord Kelvin in the middle of the last century presented a paper at the Royal British Academy on this subject, calling attention to its possibility. The principle of reversed cycle heating has been dormant for a number of years until the rapid development of refrigeration and the increasing demand for air conditioning reopened this field. Since it is possible using a refrigerating compressor as a heat pump to supply 2 to 3 times the expended electrical energy in the form of heat, engineers soon discovered the commercial possibilities of such heating equipment, operating with an apparent efficiency of 300 per cent. The refrigerant circulated by the compressor in this case is a heat carrier, and the heat is obtained from outside sources, such as the air.

One of the largest air conditioning systems using this principle is installed in the new office building of the Southern California Edison Co. in Los Angeles, Cal., and this installation has been the subject of various technical papers. The results of a number of tests operating under different conditions indicate a coefficient of performance of 3.41 and 2.7 as the ratio of Btu given off at the condenser to the Btu equivalent of the power necessary to run the compressor. Since the installation is transferring the heat from the condenser to the evaporator with water, and is using a cooling tower to absorb heat from the outside air, the overall coefficient of performance considering all auxiliaries is reduced to 1.98 and 1.45. Since in this case the refrigerating equipment was installed primarily for cooling and air conditioning, the heating is not charged with the cost of the refrigeration equipment, and the cost of heating is therefore indicated at about half the normal cost of electric heating

Heat Pump Principle

In order to describe the cooling, as well as the heating function of an air conditioning unit, it is desirable to briefly review the essential parts that enter into this conversion of energy based on the Carnot cycle.

Any refrigerating equipment of the compression type consists primarily of a compressor, condenser, expansion valve, and evaporator. The refrigerant that is circulated in this system carries the heat absorbed at the evaporator or low side to the condenser, where it is extracted at a considerably higher temperature. To accomplish this heat conversion the liquid refrigerant evaporates at a comparative low pressure and temperature in the evaporator, or low side of the system, thus changing its physical state. The latent heat of vaporization necessary for this change is supplied by the medium surrounding the evaporator, thus cooling the surrounding air. The refrigerant gas is then compressed and pumped to the condenser where it again changes its state, giving off its latent heat at a higher pressure. The total amount of heat is the heat absorbed at the evaporator plus the heat equivalent of the work of compression. The liquified refrigerant is then expanded into the evaporator to repeat its cycle.

The refrigerating compressor acts as a heat pump, transferring heat from one place to be cooled to another to be heated, as water is pumped from one level to a higher level. It is the application of this principle that determines whether it is desired to cool or heat by refrigeration. Cooling by refrigeration as applied to air conditioning is quite well established in daily life, and it is considered natural that the heat absorbed from the air to be cooled, finds its way into the condenser water, or in case of air cooled condensers, into the outside air. However, if the evaporator of a refrigerating system is placed in contact with the outside air and the condenser is located in a space to be heated, heat can be absorbed from the outside air and given off indoors.

Efficiency and Cost of Heating by Refrigeration

This discussion is based on the performance of a self-contained air conditioner with an air cooled condenser, equipped for reverse cycle heating. Although the figures used are calculated from test results and are correlated with certain assumptions that are logical, they are nevertheless on the safe side as demonstrated by actual performance in the field.

For example, assume a modern office building room of 5,000 cu ft content with northwest exposure, having three occupants, one air change per hour, average wall construction and single glass surface. To air condition this space in summer, maintaining a differential of 10 to 12 F between the inside and outside air, to dehumidify the room air and to add an adequate mixture of fresh air, it is necessary to provide a cooling load of 1½ tons of refrigeration.

To indicate the heat output in Btu per hour at various outside temperatures, three curves are plotted on the lower part of Fig. 1, representing the heat obtained from the outside air, the heat obtained from the outside air plus the work of compression, and other losses that are converted into heat. The top curve gives the total

*Product Engr. for Air Conditioning, De La Vergne Div., Baldwin-Southwark Corp.

Paper presented at the Philadelphia Chapter.

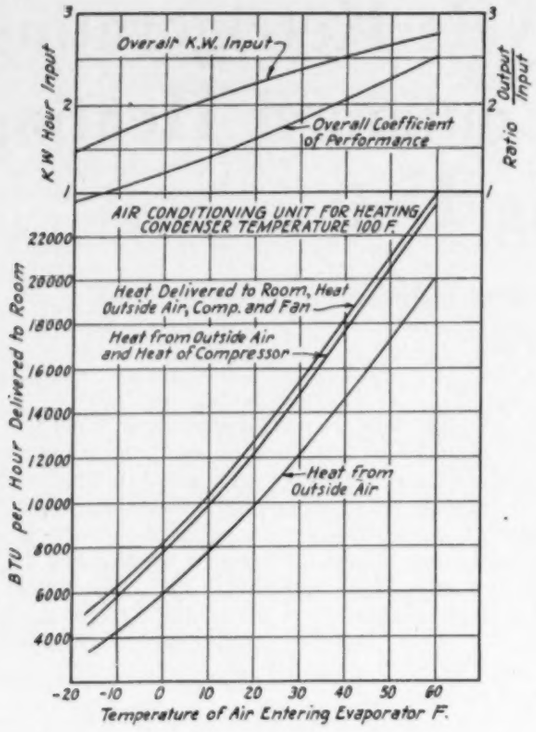

Overall K.W. Input
Overall Coefficient of Performance
AIR CONDITIONING UNIT FOR HEATING
CONDENSER TEMPERATURE 100 F.
Heat Delivered to Room, Heat Outside Air, Comp. and Fan
Heat from Outside Air and Heat of Compressor
Heat from Outside Air
K.W. Hour Input
Output / Input Ratio
BTU per Hour Delivered to Room
Temperature of Air Entering Evaporator F.

Fig. 1—Overall power input and heat output in Btu per hour

heat obtainable, including the power to drive the fan for air circulation. These curves are based on the performance of a sealed type compressor using Freon as the refrigerant, a condenser temperature of 100 F, equivalent to 116.9 lb per sq in. gage pressure, variable suction pressures as a function of outside temperatures, the performance characteristic of the coil used, and when used for heating, 1000 cfm air circulating over the evaporator and 600 cfm air flowing over the condenser which carries the heat into the room. For example, using 40 F outside air, 18,200 Btu per hour can be utilized for heating from the unit.

On the upper part of this chart is plotted the overall power input to operate the compressor and the fans, including all mechanical and electrical losses under the same outside temperature conditions represented by the Btu curve. For the same conditions of 40 F an overall power consumption of 2.55 kw is obtained from the curve. Combining the two curves to obtain the ratio of Btu given off as useful heat to the thermal equivalent of expended energy, the curve of the overall coefficient of performance is obtained. For the assumed conditions of 40 F this coefficient is 2.08, indicating that over twice the heat can be obtained by reversed refrigeration as compared to electric heating at this outside temperature. At 60 F outside air this coefficient is 2.56 and it becomes 1 at —13.5 F.

The heating capacities given and the calculated coefficients of performance have been demonstrated by a number of tests on units installed during the winter in the south, on observations in a typical office installation and on units of 3 ton cooling capacity in railroad installations.

The performance to be described demonstrates that heating by refrigeration can be accomplished satisfactorily in a temperate climate, even under extreme weather conditions. A self-contained air conditioner was installed in a corner office with northeast exposure, of 5,000 cu ft content with an average occupancy of two persons. The unit was run continuously 24 hours per day for 47 days, or a total of 1,128 hours. Continuous watt-hour meter readings were taken. The total power consumption for this period between December 17, 1934, and February 2, 1935, was 2,780 kw, or 2.46 kw per hour. During this time the outside temperatures, according to reports of the U. S. Weather Bureau varied from 61 F on January 8 to 3 F on January 28, averaging 32.6 F. The inside temperature during office hours varied from 71 to 76 F.

Limits of Heating Range

Since air conditioning equipment is usually installed for summer cooling, and since it is designed for sufficient capacity to take care of the summer load, a comparison of the heating capacity of this equipment with the heat requirements of the space to be conditioned at various outside temperatures is desirable. From the heat output curve of a 1½ ton unit, and from heat requirement calculations of the assumed 5,000 cu ft room, Table 1 results.

Table 1—Comparison of Room Heat Requirements and Heating Capacity of Air Conditioning Unit

Outdoor Temp. F	Heating Capacity Btu	Heating Requirement Btu	Ratio of Available Heat to Requirement
60	24,000	1,800	13.35
50	21,200	4,800	4.42
40	18,200	7,800	2.33
30	15,400	10,800	1.40
20	12,700	13,800	0.92
10	10,400	16,800	0.62
0	8,200	19,800	0.42

The figures in Table 1 indicate that cooling equipment designed for the normal summer load of a given room will supply sufficient heat on the reversed cycle down to an outside temperature of approximately 22 F. This limit will be lowered if the load of occupancy is a large factor in the cooling calculation, such as in theaters or in a standard railroad coach. Generally if lower winter conditions have to be considered, the refrigerating equipment should be proportionally larger.

Comparative Costs of Heating

A comparative cost of heating by refrigeration with other sources of heat, as a function of outside temperature, and cost in cents per hour for the assumed room of 5,000 cu ft are shown in Fig. 2.

The cost of heating with coal is based on a heat content of 12,000 Btu per lb at $10.00 per ton. The overall thermal efficiency is assumed to be 45 per cent. Oil at 20,000 Btu per lb heat content, costing 8 cents per gallon, and an overall thermal and electric and mechanical efficiency of 55 per cent is assumed. Gas at 500 Btu per cu ft heat value, costing 50 cents per 1000 cu ft and a thermal efficiency of 65 per cent is assumed for these calculations. Direct electric heating is figured at 2 cents per kwhr.

On this basis the cost per 10,000 Btu for various fuels is:

Coal	Oil	Gas	Electricity
0.925 cents	1.03 cents	1.28 cents	5.80 cents

The cost of heating by refrigeration is determined by figuring the percentage of operating time, assuming thermostatic operation as a function of the heating requirement. The cost of electric power is based on 2 cents per kwhr.

It appears from the equipment used that the lower the outside temperature, the less heat can be obtained economically by the reversed refrigeration cycle. It has, with some exceptions, a field for all year application in more moderate climates such as California, Georgia, Florida, etc. An air conditioning unit embodying this heating feature has, however, a distinct value in cooler climates during the Spring and Fall months and in Winter, with outside temperatures above approximately 20 F.

Basis of Design of Self-Contained Air Conditioner

In designing an air conditioner for use in offices and homes, simplicity, reliability and compactness is of primary importance. A determining factor for its success is also the first cost of such equipment and its economy of operation.

First of all, an air conditioning unit must be of adequate capacity not only to cool the air within a room from 10 to 12 F below the outside temperature, but also a corresponding reduction in the humidity must be effected. A very definite cooling capacity to adequately air condition a room can be calculated, considering the following factors which are well established among air conditioning engineers:

1. Heat leakage through walls, floors, ceiling and windows.
2. Sun and exposure effects.
3. Heat load caused by occupants.
4. Heat load due to lights and other sources.
5. Latent and sensible heat load of ventilation.

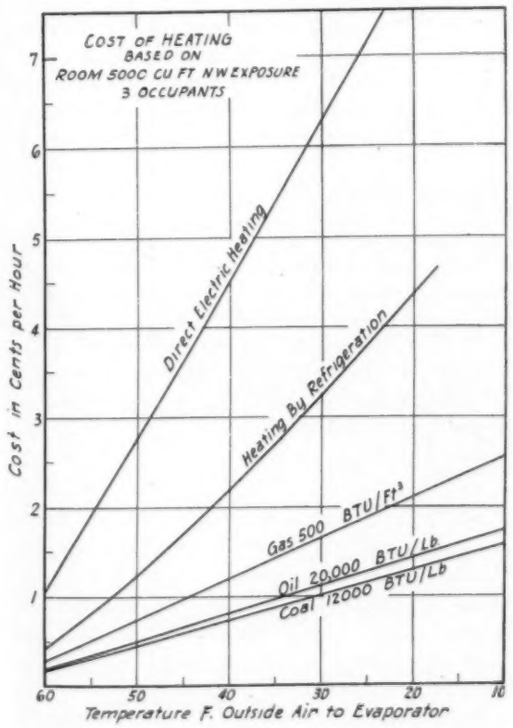


Fig. 2—Comparative cost of heating by refrigeration

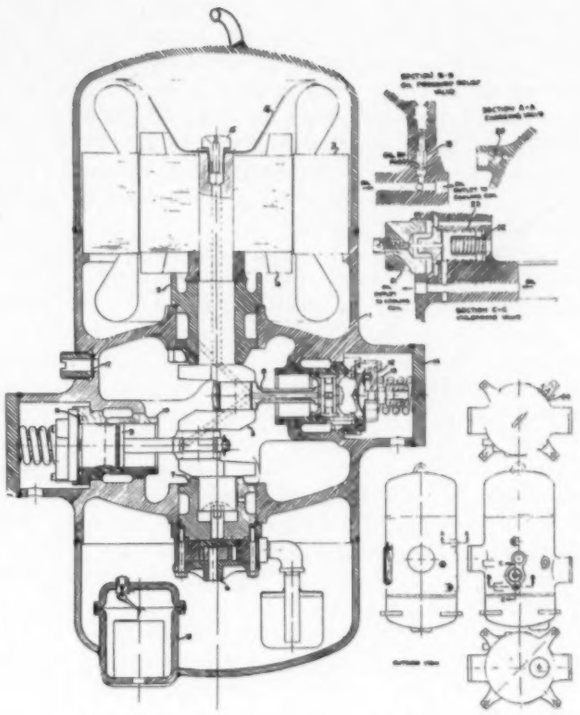


Fig. 3—A hermetically sealed compressor unit

The average air conditioning cooling requirements for a room of 3,500 and 5,000 cu ft content were determined as 1 and 1½ tons of refrigeration respectively.

Where the application of a central system is not contemplated for either economic or technical reasons, a study of the fundamental requirements of an air conditioning unit were assumed to be:

1. Units to be self-contained and factory assembled.
2. They should be as compact as possible.
3. The refrigerating system should be hermetically sealed.
4. The design should lend itself for quantity production.
5. The noise level to be kept within permissible limits.
6. The refrigerant to be not injurious to health.
7. Simplicity of operation and installation.
8. Economical in operation.
9. Pleasing appearance.
10. Units to be designed for air conditioning requirements in summer and winter.

It is obvious that an air conditioner to be used in such places as homes or offices should not require expensive piping connections. These would be necessary if a remote installed compressor is used and, also, drain connections would be essential for the moisture condensed from the air. A unit designed so that it can be put into operation by merely connecting it to the electric supply and placing it convenient to an outside air supply is desirable. All integral parts should be mounted on a suitable base and the supporting frame attached to a back sheet thus forming a solid chassis.

Fig. 3 shows a hermetically sealed compressor unit which has been previously described.[1] It is a direct connected vertical compressor having two cylinders at 180

[1]Room Cooler Design, by C. R. Neeson, *Refrigerating Engineering*, November, 1933.

deg 1½ in. bore and 1¾ in. stroke running at 1750 rpm. The motor is mounted within the compressor housing thus permitting a hermetically sealed construction that does away with the conventional stuffing box. This arrangement has, in addition to being compact, the advantage of being inherently balanced, permitting easy machining and assembly within the scope of modern production methods and the testing of the fully assembled compressor under pressure.

The main housing (1) is of cast steel and machined to receive the motor stator (2), the two cylinder liners (10), and the crankshaft bearings (5 and 7). The vertical two throw crankshaft (3) with the upper bearing and the rotor (4) is a separate assembly that is dynamically balanced before assembly in the compressor. The connecting rods (8) and the pistons (9) are weighed and matched in pairs before assembly. An oil pump (6) is provided in the lower part of the compressor to provide lubrication to the moving parts and to deliver a portion of this oil through the drilled shaft to the top of the rotor where it is sprayed over the stator. The heat generated in the motor is dissipated through the oil in an external oil cooling coil.

The suction valves (11), the discharge valves (12), held down by springs (13), are then assembled and the compressor is finally closed by welding on the top and bottom, the cylinder heads (14), crankcase cover, and external piping. It is then ready for a test with air at 250 lb per sq in. under water. Also built in are rupture disc (17), oil return trap (18), oil pressure regulating valve (19), charging valve (20), oil pressure actuated unloader (21-22-23) and electrical connections similar to spark plugs.

A fully sealed machine is obtained of rugged construction but of light weight and ample strength. Since all moving parts are enclosed, the outlines are extremely simple. As all joints are either welded, brazed or soldered and ample lubrication is provided within, this compressor is leak proof, cannot be tampered with and assures satisfactory performance for a long time.

Fans

The following description of the fans and heat exchanging coils refers to their function in the cooling cycle.

Two fans of multiblade type are overhung on the shaft extensions of a special ½ hp fan motor running at 1750 rpm. The fans are designed for quiet operation within the limits obtainable. The whole assembly is mounted on vibration absorbers similar to the compressor mounting. They rotate in fan scrolls that are spot-welded to the steel frame.

The evaporator fan has a capacity of 600 cfm against the static resistance of the system. It draws room air and a portion of fresh air into its inlet and discharges it upward through the evaporator coils located within a cork insulated casing. The air, being cooled on its upward passage through the fin type evaporator, deposits condensed moisture on the fins, which drops into troughs, located in the air stream. The cooled and dehumidified air is discharged at the top and directed at proper velocity at an angle of approximately 70 deg with the horizontal into the room.

The condenser air fan communicates with the compressor compartment. Outside air for condenser cooling is drawn by the suction of this fan through a duct inserted under a partly opened window. This air enters the unit through a hole in the back sheet and is directed downward over the compressor and over the oil cooling coil. It is then discharged through a slotted tray which forms a series of troughs and thence through the condenser.

Water Disposal

The troughs in the evaporator air circuit and underneath the condenser communicate with each other. On its upward path through the slots, air picks up water particles of the moisture condensed out of the room air stream and sprays it against the hot condenser, evaporating it into the air stream. A few water particles are discharged in form of small drops. The air is then discharged to the outside through a duct parallel to the intake. This re-evaporation and spraying of the moisture obtained from the cooled air and its discharge to the outside, eliminates the necessity of a drain connection.

Evaporator and Condenser Coils

The evaporator and condenser coils are of similar design with horizontal return bends and with vertical continuous fins spaced at 6.3 fins per inch. The coils are constructed of copper.

Refrigerant

The refrigerant used in the unit is Freon (F12). It has been used quite extensively for a number of years in air conditioning installations primarily for its safe characteristics. Its use, however, has introduced a number of manufacturing problems. Since it is odorless, leaks are hard to locate and rigid testing methods are necessary, and as a result a sealed unit with all joints welded or soldered has proven desirable. Its mixability with mineral oil in practically any proportion has caused some difficulties. It is also essential to evacuate the units thoroughly preparatory to charging in order to remove all moisture within the system and to prevent corrosion by acids that would form as a result of a chemical reaction of Freon in the presence of water.

Unit Provides Ventilation

Due consideration was given to the ventilation function of air conditioning and the unit was designed for a fresh air supply of 10 to 15 per cent of the recirculated air. This air is cooled and dehumidified before introducing it to the room. Although this causes an increase in the cooling load, it was found desirable, and in later machines this principle was even intensified by providing a positive air exhaust that cleared the smoke and tobacco odors from the air.

Noise Problem

One of the most difficult problems to be solved in connection with the development of a unit of this type is the reduction of noise. To produce a self-contained unit, embodying a high speed compressor and fan equipment for room air circulation and the supply of condenser air, all within the very compact dimensions permissible for a room unit requires considerable development and research. An audio noise meter indicating noise levels in

decibels is indispensable considering that noise is relative and because reaction to noise is greatly influenced by physical conditions.

By rubber-mounting the compressor and fan motor, as well as the base carrying the whole equipment, and sound treating the air passages, the noise level of the unit was reduced to an average of 50 decibels measured at a room noise level of 25 to 27 decibels. This method of sound determination has been established for a number of years and can be defined by the relation

$$N \text{ db} = 10 \log_{10} \frac{P_1}{P_0}$$

where N indicates the ratio of the measured sound pressure P_1 to the 0 sound pressure taken as 0.001 bar (dynes/cm^2).

Cabinet

The mechanical parts of the air conditioner are concealed by an attractive cabinet properly sound insulated and equipped with an air filter.

Method Used to Effect Reversal of Unit

The reversal of the cycle of the air conditioner is accomplished by the inter-connection of the evaporator and condenser coils with the compressor. To change the direction of flow of the refrigerant an arrangement of four valves may be used, but in order to effect this reversal by simple mechanical means an assembly of two cocks is used. Each of these cocks has two ports that can be brought into communication with the discharge and suction connection to the compressor. The movement is effected by the use of a screw that can be turned from the outside of the unit with a crank or through a simple lever mechanism.

A further refinement is obtained by the use of a small motor to effect the reversal. The unit will then change from cooling to heating and vice-versa by the touch of a button or automatically if connected to a suitable thermostat. It is possible to foresee that an air conditioner of such flexibility and simplicity of operation, which provides comfort without resorting to remote auxiliaries, has a very definite field of application in homes, offices, public carriers, commercial establishments, and industrial processes.

Application of Reversible Unit to Railroad Installation

The simplicity and compactness that can be achieved in the design of a self-contained air conditioning unit, which fulfills summer requirements for cooling and will heat in winter, has also been appreciated by railroad engineers. Heating by this method is desirable on electrified lines, especially on multiple unit cars that are at present equipped with direct electric heaters. Lower operating cost results and a corresponding higher return on the original investment is effected because of all year operation. The conditions of comfort are considerably improved by the use of air conditioners using the heat pump principle for heating. Positive ventilation and air motion is provided in this case, eliminating the feeling of stuffiness often found in heated cars.

Figs. 4 and 5 show the installation of the complete assembly in the monitor top of a railroad car usually at the end above the washroom, leaving a headroom of 7 to 8 ft below the units depending on the height of the cars. Fig. 6 shows an interior view of the air supply and return grilles in the monitor top of a car. Locating the units in this manner permits ready accessibility, economy of installation and the minimum amount of alterations of car structure and equipment.

The installation of an air conditioner using the cooling and heating function of refrigeration was made in a car of the Pennsylvania Railroad operating between Philadelphia and Paoli. This car is in daily service since July 1934, giving comfort to suburban commuters throughout the year. Two units were used per car, located at each end, giving a combined cooling capacity of 6 tons of refrigeration. The units are operated with 230 volt single phase 25 cycle current, and they are controlled for winter and summer operation by suitable thermostats and electrical control equipment protecting the motors at frequent current interruptions.

Description of Three Ton Railroad Unit

These units embody a sealed type compressor, fans, condenser and evaporator coils, reversing equipment, eliminators, condensation pans and interconnecting piping, all mounted within an electrically welded trusswork

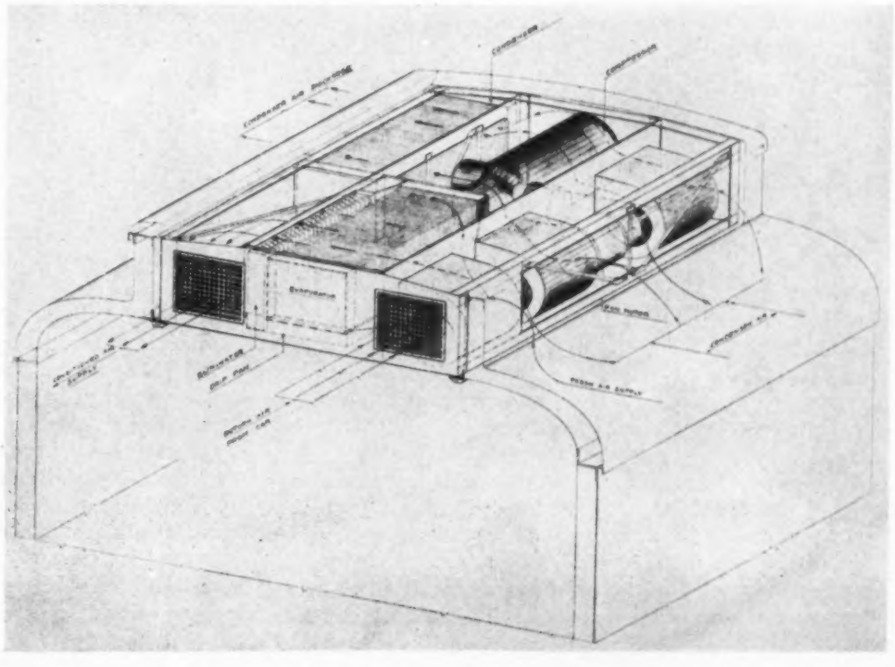


Fig. 4—Installation of complete assembly in monitor of railroad car

Fig. 5—View of 3-ton railroad unit in monitor of car

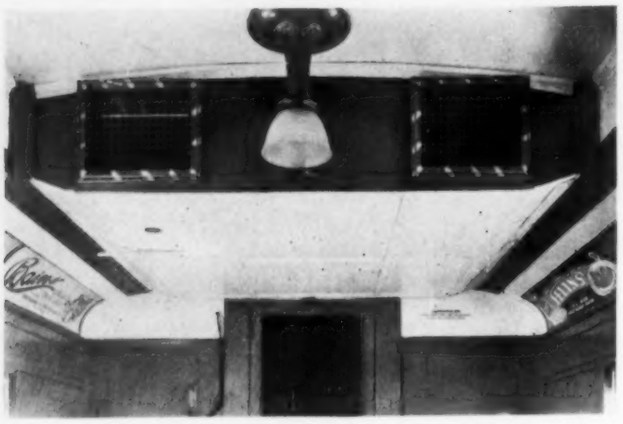


Fig. 6—Interior view of railroad car showing air supply and return grilles of monitor unit

braced with seamless tubing and enclosed with aluminum covers. All moving parts are mounted on rubber vibration absorbers. For ease of inspection they are readily accessible from the bottom of the unit.

Internal partitions divide the unit into the low and high side, with the former comprising the car air circulating fan, evaporator, eliminator plates and communicating air passages leading to the discharge grille, and the latter consisting of two condenser air fans which are direct connected to a 1-hp 1450 rpm motor, compressor, oil cooling coil, condenser, and interconnecting ducts with the outside air.

The reversing equipment, designed along similar lines to the one used on the smaller unit, is located in a separate compartment and is actuated from below the unit.

The compressor having two cylinders, 2⅜ in. bore and 2⅛ in. stroke, is similar in construction to the one previously discussed. It is direct connected to an oversize 5 hp motor operating at 1450 rpm. To satisfy space requirements it is designed for horizontal mounting.

2000 cfm outside air is drawn through filters from one side of the upper deck of the car, circulated over the compressor and condenser, and discharged at the opposite side of the car to the outside. The car air is drawn through an opening in the front of the unit, is mixed with approximately an equal amount of fresh outside air and is then delivered to the car through a discharge grille at proper temperature, velocity and direction. The capacity of the car air fan is 1000 cfm.

Since the function of the evaporator and condenser coils are interchangeable, cooling and dehumidifying are obtained from the unit if the coil in the car air stream is used as an evaporator. Heat is then extracted from the car air and given off through the condenser air to the outside. If heating is to be accomplished, the coil in the car air passage is used as a condenser, and gives off the heat picked up by the coil in the outside air passage, which is used in this case as the evaporator.

The mounting details of the units, are designed to withstand a deacceleration from 25 mph to a dead stop in 1/10 second. Electrical safeguards are used against current interruptions preventing the starting of the compressor motor against headpressure and allowing it to stop at section breaks of the power lines.

Table 2 shows the results of cooling tests conducted on a railroad car equipped with two 3-ton air conditioning units.

Table 2—Cooling Tests of Car Equipped With Air Conditioning Units

Date	Duration of Test.	Outside Temp. F	Avg. Car Temp. F	Temp. Diff.	Avg. No. Passenger	Disch. Press	Suct. Press	Remarks
7-2-34	5 hr 15 min.	95.7	81.5	14.2	..	242	35	
7-3-34	3 hr 25 min.	95.5	84.75	10.75	26	243	35	
7-3-34	2 hr 20 min.	91.7	79.5	12.4	17	...	..	
7-16-34	1 hr 45 min.	88	71	17	18	212	37	
7-30-34	2 hr 20 min.	81.5	72.5	9	19	177	37	1 Unit off 31% of time.

A number of tests were made to determine the heating value of the units. The following are the results:

Avg. % Fresh Air	Outside Temp. F	Discharge Temp. F	Recirc. Air Temp.	Heat Output, Btu	Overall Coeff. of Perform.
36.6%	40.5	115	81.5	55800	2.56
36.6%	31.1	101	70.5	52500	2.54

The coefficients of performance are approximate, since no watt-hour meter readings were taken simultaneously. As these cars are normally heated with electric strip heaters a considerable saving in the heating with refrigeration is effected in addition to the improvement of comfort by the proper ventilation.

Future Development of Heating by Refrigeration

Reviewing the results that can be accomplished with heating by refrigeration in connection with summer air conditioning, it is possible to predict, that the near future will see an ever-increasing application of this principle.

Its growth is dependent on a source of electric power available at reasonable cost. The maximum development of this form of heating is expected in moderate climates, and for applications that necessitate installation of equipment to take care of heat loads in excess of the mere cooling and dehumidifying of air.

If air conditioning is considered basically as a method of controllng summer conditions, and its installation is justified for reasons of increased profit and comfort, then the heat obtainable by the reversed refrigeration cycle is an additional source of energy that can be utilized profitably.

NOMINATIONS FOR 1936

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1936, submits the following list of nominees:

For President:

G. L. LARSON, Madison, Wis.

For First Vice-President:

D. S. BOYDEN, Boston, Mass.

For Second Vice-President:

E. H. GURNEY, Toronto, Ont., Can.

For Treasurer:

A. J. OFFNER, New York, N. Y.

For Members of the Council:

Three-Year Term

R. C. BOLSINGER, Norristown, Pa.
S. H. DOWNS, Kalamazoo, Mich.
W. L. FLEISHER, New York, N. Y.
C. M. HUMPHREYS, Pittsburgh, Pa.

Respectfully submitted,

NOMINATING COMMITTEE,
E. A. JONES, *Chairman;*
R. J. TENKONOHY, *Secretary.*

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—Section 10. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the JOURNAL.

Art. B-IX—Section 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and amended January, 1933, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1936:

Three-Year Term

W. A. DANIELSON, Washington, D. C.
C. E. LEWIS, Dayton, Ohio.
D. W. NELSON, Madison, Wis.
CYRIL TASKER, Toronto, Ont., Can.
C.-E. A. WINSLOW, New Haven, Conn.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's JOURNAL.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

Buckingham Fountain and Michigan Avenue

Check the Calendar—
Chicago
January 27-31

THE Big Week in 1936 for the heating, ventilating and air conditioning profession and industry will be January 27 to 31, when the Society members will gather at the Palmer House, Chicago, for the 42nd Annual Meeting; during the same period the *National Warm Air Heating and Air Conditioning Association* will hold its mid-year meeting at The Stevens and the fourth International Heating, Ventilating and Air Conditioning Exposition will be in the International Amphitheatre.

Everyone connected with the profession and industry will want to be in Chicago to learn of the latest research developments, to hear the technical papers and reports and see the new equipment offered for maintaining winter and summer comfort.

For the Society, Illinois Chapter members will make all arrangements under the direction of J. H. Milliken. Committees are now being organized to handle the entertainment program.

Several get-together functions are being planned and members will be advised of the details in the near future. Everything possible will be done for the enjoyment of the visitors. A special program is planned to attract the ladies and make them remember a very pleasant visit to Chicago. There will be fun for everyone.

The annual banquet will be an important social function and in addition to special entertainment the program includes the presentation of the F. Paul Anderson Medal and the Past President's Emblem.

It will be worthwhile to attend the meetings and exposition. The cost will be very moderate as special rates are available to Society members at the headquarters hotel and reduced round-trip fares have been granted by the railroads under the identification certificate plan.

Headquarters for the Society meeting will be established at the Palmer House conveniently situated in the loop at Monroe

Foyer where registration will be held

The Field Museum

and State Streets, giving immediate access to the downtown business district, retail stores and theaters. Special taxicab rates, bus and elevated service have been arranged from the hotel door to the Exposition and this information will be supplied to all guests when they register.

Registration headquarters will be opened at 9:30 a. m., Monday, January 27, in the ballroom foyer on the fourth floor of the Palmer House. Badges, programs, and all essential information will be furnished to members and guests. Technical sessions will be conducted in the Red Lacquer room and President John Howatt of Chicago will preside.

All of Monday, January 27, will be devoted to committee meetings and on each of the three following days technical sessions will be held from 9:30 a. m. to 12:30 p. m. Some of the subjects chosen for discussion are:—Summer Comfort Standards, Minimum Air Requirements for Ventilation, Railway Air Conditioning, Heat Transfer from Finned Tubing, Corrosion in Steam Lines, Heat Transmission through Concrete Walls, and Sound Insulation. The program committee is working to provide a comprehensive and interesting program and the exposition will cover all phases of heating, ventilating, and air conditioning, and is the fourth in a series of highly successful presentations directed by Charles F. Roth.

The first Show was in Philadelphia in 1930, the second in Cleveland in 1932, and the third took place in New York in 1934. The appropriateness and popularity of the Exposition is indicated by the increasing attendance and number of exhibitors. Four months in advance of the date of the Fourth Exposition 178 spaces in the great Amphitheatre have been taken by 128 exhibitors, necessitating the use of both wings of the Amphitheatre. The early planning for the Exposition indicates that the industrial organizations exhibiting are preparing to make their presentations outstanding, both from the standpoint of technical timeliness and appropriate stage setting.

The scope of the Exposition is comprehensive and timely because it includes every field of industry related to the proper conditioning of the air we breathe in the interests of health, comfort and efficiency. The summer just past has emphasized the need for effective air conditioning installations, while the coming winter season brings up the question of adequate heating and ventilating for every type of building.

Principal sections of the Exposition will include boilers and furnaces, steam, air, and hot water heating systems, hydraulic equipment, air conditioning apparatus of every type, ventilating systems, refrigerating systems, central heating and unit heating, insulation materials, and precision instruments to provide regulation and control for every type of installation, whether in home, office or factory.

Admission will be by invitation or registration only. No tickets are sold, and the plan of admission restricts attendance, giving everyone who is interested an unhurried opportunity to examine the many exhibits in each specialized field.

International Amphitheatre

PRESIDENT'S MESSAGE

The number of men engaged in or interested in the heating, ventilating or air conditioning profession and industry is increasing by thousands each year. Many of these men are qualified for membership in our Society but have not yet affiliated themselves with us. They need membership in our Society for what it can do for them and the Society needs them to strengthen and broaden the influence and effectiveness of its work. The needs of each should be satisfied.

A membership in this Society gives more return for the money invested than can be had in any other way. $7.20 of each member's dues goes to support our research, so the member is the important factor in the development in the heating, ventilating and air conditioning field. The head of one of the largest industries in the United States recently stated that it is dangerous for any business not to make provision for the future. Our maintenance of a research program to develop facts and ideas in the field in which we are principally interested is our provision against that dry rot that comes through lack of progress.

For the balance of the dues, $10.80, the member receives THE GUIDE, which is recognized as the most authoritative publication in its field; THE TRANSACTIONS, which is the authentic record of the progress in the art; a subscription to *Heating, Piping and Air Conditioning*, which monthly publication carries our JOURNAL SECTION; various codes, standards and special reports as prepared and adopted; and perhaps most important of all he receives the opportunity for service in his chosen field with the privilege of attending all meetings as a member and contributing to and taking part in the deliberations of Chapter and Society meetings.

Your time and your money spent on Society matters is well spent. The men who have been most important in the development of the heating, ventilating and air conditioning industry belong to and actively support the Society, so those who support it by their membership are not only materially benefiting themselves but can have the pride of association with the leaders in industry who are helping you to carry on the work.

Be proud of your membership and resolve that in this new year of Society affairs you will attend as many as possible of your Chapter meetings and contribute something to them; support your officers and make this year one of enthusiasm and good feeling.

President,

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

October 1, 1935

Meeting of Joint Committee on Refrigeration

The Joint Committee on Rating Commercial Refrigerating Equipment, sponsored by the *American Society of Refrigerating Engineers*, held a meeting in Detroit September 10-11. On this occasion the A. S. H. V. E. was represented by W. E. Stark, Cleveland, O., F. H. Faust, Schenectady, N. Y., and C. W. Walton, Jr., New York, N. Y., who has been appointed to serve by Pres. John Howatt.

The scope of the Joint Committee's present activities is the preparation of recommended rating and test methods for mechanical condensing units and air conditioners used in combination with them.

Among the subjects of discussion at the meeting were condensing unit ratings and test procedure, condensing unit application data, and air conditioner ratings and test procedure and application data.

Building Code Correlating Committee Organized

The organization by the *American Standards Association* of a Building Code Correlating Committee was effected on September 17 with a meeting in the Engineering Societies Building, New York City. R. P. Miller, former building code commissioner of Manhattan, was elected chairman of this committee and G. N. Thompson, National Bureau of Standards, was named vice-chairman. The *A. S. A.* was asked to undertake work on a national building code by Secretary Roper of the Department of Commerce, when the Department's Building Code Committee was disbanded.

The Correlating Committee will supervise the work of several sectional committees, which will be assigned to develop building standards and specifications to be made available to municipalities developing local building codes.

Members of the Building Code Correlating Committee and their representatives are: *American Institute of Architects*, J. A. Fouilhoux, H. R. Dowswell, alternate; *American Municipal Association*, W. P. Capes, A. H. Hall, alternate; *American Public Health Association*, A. E. Gorman, W. S. Johnson, alternate; *American Society of Civil Engineers*, R. P. Miller, M. S. Rich, alternate; *American Society for Testing Materials*, R. P. Miller, R. E. Hess, alternate; *Associated Factory Mutual Fire Insurance Companies*, F. T. Moses, A. L. Brown, alternate; *Associated General Contractors of America*, W. F. Sustin, D. T. Webster, alternate; *Building Officials' Conference*, E. W. Roemer, F. C. Keller, alternate; *Federal Housing Administration*, M. L. Colean, A. C. Shire, alternate; *Forest Products Laboratory*, J. A. Newlin, L. J. Markwardt, alternate; *International Association of Governmental Labor Officials; National Association of Building Owners and Managers; National Association of Builders' Exchanges*, E. Diebitsch; *National Association of Real Estate Boards*, H. U. Nelson; *National Board of Fire Underwriters*, W. E. Mallalieu, C. T. Bissell, alternate; *National Bureau of Standards*, George Thompson, V. B. Phelan, alternate; *National Fire Protection Association*, F. H. Wentworth, R. S. Moulton, alternate; *National Safety Council*, W. D. Keefer, alternate; *Pacific Coast Building Officials Conference*, D. H. Merrill, Walter Putnam, alternate; *Procurement Division*, Treasury Department, C. W. Chamberlain, H. H. Waples, alternate; and *Public Health Service*, Treasury Department, R. R. Sayers, R. H. Britten, alternate.

The Correlating Committee has elected an Executive Committee to develop a plan of procedure and the members are: J. A. Fouilhoux, W. P. Capes, W. F. Austin, E. W. Roemer, and W. E. Mallalieu.

Annual Reports of Local Chapters

Cincinnati

The Cincinnati Chapter has planned meetings at the Engineers Club on October 8, November 12, to be a joint meeting with the Engineers Club, and December 10, 1935, with the following respective programs scheduled: Local Air Conditioning Installations—J. J. Braun and K. A. Wright; Heating and Ventilation in Connection with Municipal Power and Sewage Projects—E. B. Royer, and F. J. Ward; and Study of Summer Cooling Standards.

Secy. I. B. Helburn has prepared the annual report and 30 members are now on the Chapter's roll of membership.

The officers and committees are:

President—G. B. Houliston.
Vice-President—E. B. Royer.
Secretary-Treasurer—I. B. Helburn.
Board of Governors—E. B. Royer, H. E. Sproull, H. N. Kitchell, G. B. Houliston, I. B. Helburn.
Meetings Committee—O. W. Motz, *Chairman*, E. B. Royer, R. B. Breneman and Anker Winther.
Membership Committee—K. A. Wright, *Chairman*, L. G. Powers, C. E. Hust and G. B. Houliston.
Finance Committee—R. E. Kramig, Jr., *Chairman*, H. A. Pillen, E. J. Richard and I. B. Helburn.
Legislation Committee—H. E. Sproull, *Chairman*, H. N. Kitchell, J. J. Braun and C. J. Kiefer.
Publicity Committee—R. W. Sigmund, *Chairman*, W. C. Pistler, and J. A. Smith.

A resumé of meetings held from December 1934 to the present date is given:

December 11, 1934. R. B. Breneman spoke on the history of cork as an insulating material and showed a two-reel motion picture, entitled The Story of Cork. The Use of Building Insulation for Economic Heat Control was presented by G. P. Diers. T. S. Lewis showed a motion picture on the manufacture and method of installation of rock wool insulation.

January 8, 1935. The annual meeting was held at the Hotel Gibson when a social meeting and election of officers took place. Attendance—40.

April 16, 1935. John Howatt, Chicago, Ill., president of the A.S.H.V.E., spoke on Standards for Heating, Ventilating and Air Conditioning. Attendance—17 members and 10 invited guests.

May 15, 1935. Joint meeting with Engineers Club. Local air conditioning installations in the Shillito Department Store and the Carew Tower Development were discussed by W. H. Junker and Anker Winther. Attendance—125.

Michigan

Approximately 100 members are on the rolls of the Michigan Chapter and the following officers are in charge for the coming year:

President—A. C. Wallich.
Vice-President—R. K. Milward.
Treasurer—F. J. Feely.
Secretary—W. F. Arnoldy.
Board of Governors—R. F. Connell, Edward Glanz, A. P. Darlington.

A synopsis of meetings has been prepared from the monthly reports submitted during the past season:

October 10, 1934. A golf tournament at the Detroit Golf Club in the afternoon was followed by dinner and a meeting. The speaker of the evening was H. R. Smith, attorney for the *Michigan Bankers Association*, who explained the operation of the Better Housing Program under the National Housing Act. A government visomatic talking picture was also shown.

November 12, 1934. Rev. Frederick Siedenburg, executive dean of the University of Detroit and director of the Detroit Regional Labor Board, discussed Some Aspects of the New Deal. J. L. Fuller, chairman of the Field Survey of the Detroit Better Housing Program, outlined the work of the local committee. The remainder of the evening was devoted to a technical discussion of stokers with R. L. Beers as the principal speaker.

December 10, 1934. A dinner and meeting was held at the Dearborn Inn. After completion of routine business, the members and guests inspected the power plant of the Ford Motor Co.

January 8, 1935. This meeting was sponsored by the Detroit Edison Co. and was attended by approximately 70 members and guests. After dinner a short film was shown of the volcanic eruption of Krakotoa. F. M. Dean was the principal speaker and discussed the subject of Delivering the Juice. After the talk, the picture, Convention City, was shown.

February 11, 1935. A dinner dance at the Dearborn Inn, Dearborn, Mich., was attended by 110 members and guests of the Michigan Chapter.

March 11, 1935. This meeting was officially announced as the Annual University Night and the program was furnished by the University of Michigan and the University of Detroit. Prof. Axel Marin, of the University of Michigan, discussed Teaching Engineering. The latter part of the program was supplied by the University of Detroit. Prof. F. J. Linsenmeyer described the testing of vacuum pumps and then introduced several students at the University of Detroit, who effectively discussed the merits of various systems of heating and air conditioning in their application to residences.

April 1, 1935. A dinner and meeting was held at the Wardell Hotel. Prof. A. P. Kratz, Urbana, Ill., spoke on the Summer Cooling Project in the Research Residence at the University of Illinois. G. B. Helmrich described tests being conducted in a Birmingham residence by the Detroit Edison Co. and summarized tests and conclusions.

May 15, 1935. The annual meeting of the Michigan Chapter included the election of officers, routine business and a golf tournament, followed by distribution of suitable awards.

Minnesota

Activities of Minnesota Chapter for the fall season began on September 17, when a meeting was held at the Bloomington Golf Club and Minneapolis Automobile Club, with golf in the afternoon followed by dinner and a talk on General Business Conditions by R. E. Saberson.

On October 14 a meeting will be held at the offices of the Minneapolis-Honeywell Regulator Co. and will include an inspection trip and a symposium on heat regulators. The annual fall party has been scheduled for November, and on December 9 a meeting will be held at the Men's Union of the University of Minnesota.

The Chapter officers and committees are:

President—C. E. Gausman.
Vice-President—N. D. Adams.
Secretary-Treasurer—R. E. Backstrom.
Board of Governors—H. M. Betts, J. E. Swenson.

COMMITTEES

Meetings
F. C. Winterer, *Chairman*
A. B. Algren
N. D. Adams
H. F. Dever
G. R. Magney
J. E. Swenson
H. S. Morton

Legislative
E. F. Jones, *Chairman*
R. W. Otto
Albert Buenger

Publicity
R. C. Jordan, *Chairman*
D. L. Sutherland
H. R. Harris

Entertainment
Fred Shernbeck, *Chairman*
F. F. Lange
M. H. Bjerken
A. J. Huch
F. W. Legler

Finance
R. E. Backstrom, *Chairman*
H. M. Betts
D. M. Forfar
G. C. Morgan

Nominating
A. B. Algren, *Chairman*
W. F. Uhl
H. E. Gerrish

Auditing
D. C. Ruff, *Chairman*
G. A. Dahlstrom
E. F. Bell

Membership

H. E. Gerrish, *Chairman*	F. W. Stiller
J. R. Roberts	T. T. Cash
J. R. Hall	William McNamara
C. E. Lund	E. F. Jones
L. H. Johnson	F. B. Rowley
L. C. Gross	W. F. Uhl

Attendance

Minneapolis, J. R. Roberts	St. Paul, D. B. Anderson

The annual report prepared by Secy. R. E. Backstrom gives a membership roll of 80 and a synopsis of meetings held during the past year.

September 17, 1934. Talks by Albert Buenger and W. A. Lang and an inspection trip through Hamm's Brewery. Attendance—65.

October 8, 1934. Vice-Pres. John Howatt of the A.S.H.V.E. and Dr. E. V. Hill, past president of the Society, Chicago, Ill., were the speakers. Mr. Howatt discussed recent activities of the A.S.H.V.E. Dr. Hill presented an illustrated talk on The People vs. Bad Air. Attendance—101.

November 12, 1934. Annual party held at the Thorpe Country Club. Attendance—77.

December 10, 1934. R. N. Trane, LaCrosse, Wis., presented an illustrated talk on Extended Heat Surfaces for Cooling, Using Water or Direct Expansion. Attendance—43.

January 14, 1935. Prof. A. B. Algren, University of Minnesota, presented a paper on Oil Burners and Their Application to Domestic Heating. Attendance—70.

February 11, 1935. H. F. Dever discussed Controls as Applied to Air Conditioning. Attendance—50.

March 18, 1935. Pres. John Howatt talked on Where We Are in regard to air conditioning and the Society's position in this industry. Attendance—80.

April 15, 1935. A talk on Refrigeration as Applied to Air Conditioning was given by H. H. McKinnies. Attendance—50.

May 18, 1935. Annual golf tournament and election of officers, held at Rochester Country Club, Rochester, Minn. The speakers were Mayor Moore and Dr. Charles Boothby, Dr. Charles Sheard and Dr. George Brown of the Mayo Clinic. Attendance—60.

New York

A synopsis of meetings held from October 1934 to May 1935 has been prepared by Secy. T. W. Reynolds in the annual report of the New York Chapter, which states that the average attendance at meetings during the past season was 103 and that the Chapter had a membership status of 200 members on Sept. 1, 1935.

The following members were elected to office for the season of 1935-1936:

President—W. W. Timmis.
Vice-President—G. E. Olsen.
Secretary—T. W. Reynolds.
Treasurer—W. M. Heebner.
Board of Governors—A. F. Hinrichsen, W. E. Heibel, H. W. Fiedler.

October 15, 1934. Addresses on the Federal Housing Administration, English practice in heating and ventilating, and the Society's activities were the three features of the first meeting of the 1934-1935 season. J. M. Gerard, regional director for the State of New York of the Better Housing Division, Federal Housing Administration, discussed the government's modernizing program, while C. V. Haynes, president of the A.S.H.V.E., told the members of the Society's activities. J. N. Russell, Westminster, England, past president of the *Institution of Heating and Ventilating Engineers* of Great Britain, who was visiting the United States, briefly reviewed some of the outstanding differences between British and American practice in heating and ventilating.

November 19, 1934. A. W. Canney spoke on air conditioning and told of some of his experiences in connection with the installation at Rockefeller Center. Mr. Canney expressed the opinion that shelter should not be considered alone as the principal objective of a building, but that healthful, comfortable indoor conditions were equally important.

December 17, 1934. G. S. Chappell, architect, who is equally well known as the famous humorist, Dr. Walter Traprock, and author of The Voyage of the Kawa, gave a humorous program which covered some of the intricacies of air conditioning.

January 21, 1935. The subject of corrosion was ably treated by three speakers, W. H. Finkelday, C. M. Sterne and V. P. Gershon. The general subject of corrosion of metals and the large annual loss due to this action was discussed by the first speaker. The second speaker gave the results of a number of tests on the use of various chemicals for preventing corrosion in air conditioning apparatus and the treatment of spray water; while the third talk on Scientific and Practical Aspects of Corrosion and Scale in Boiler Plants and Other Water Systems was illustrated with a number of experiments demonstrating a method of treating boiler waters.

February 18, 1935. Talks on pre-fabricated houses and protecting real estate equities were the features of the evening. A Completely Air Conditioned House for $3800 was the subject of D. C. Slipher. A low cost house to be sold on installments of $38.00 a month with no down payment will have two bedrooms, a living room, kitchen, and bath. The principal feature of the house is to be the motor unit placed between bathroom and kitchen and containing all mechanical equipment.

Three radically different angles of protecting real estate equities were discussed. B. J. Gillroy told how the government through the Federal Housing Administration and the Home Owners Loan Corp. is protecting real estate values, while O. O. Oaks spoke on the work of manufacturers in promoting modernizing campaigns to increase the value of buildings. In concluding the subject, D. J. Purinton explained how banks have been affected by low real estate values and their attitude in respect to the use of modernization as a means of increasing values.

March 18, 1935. A two-reel sound movie film on the general subject of sound and noise prevention with an accompanying lecture by J. S. Parkinson, and a paper by E. D. Milener, *American Gas Association*, on Summer and Winter Air Conditioning with Gas, were the features of this meeting.

The film showed graphically the difference between sounds of high and low frequency and the difference in amplitude. It showed a number of acoustical phenomena such as refraction, reverberation, echoes, etc. and covered the fundamentals of sound in a non-technical way. In his lecture, Mr. Parkinson showed how sound is measured.

Mr. Milener reviewed briefly the accomplishments of the gas industry in automatic heating and described some of the work which had been done in developing a summer conditioning unit, which will adsorb moisture for dehumidifying. In the speaker's opinion, more installations of summer air conditioning equipment can be satisfactorily operated by dehumidifying the air than by mechanical cooling with dehumidifying as a by-product.

R. H. Carpenter, the Chapter's representative on the Society's Council, reported on the method of selecting the A.S.H.V.E. Nominating Committee and discussed several methods which had been proposed.

April 15, 1935. This meeting was honored by the presence of John Howatt, president of the A.S.H.V.E. Other features were a proposal by W. L. Fleisher, chairman of the Finance Committee of the Society's Committee on Research, and the presentation of a life membership certificate to T. E. Crone.

President Howatt laid emphasis on heating, ventilating and air conditioning work in school buildings, with which practice he is especially familiar because of his work as chief engineer of the Chicago Board of Education.

Mr. Fleisher proposed that the Society adopt a new viewpoint regarding the scope of its membership and the method whereby its research activities should be financed. He outlined his ideas specifically by proposing that membership be greatly broadened and that an attempt be made to set up a substantial

endowment, initially not less than one million dollars, to support research.

May 20, 1935. The annual dinner, entertainment and smoker, under the direction of H. L. Alt and his committee, took place at the Building Trades Club and was one of the most successful ever held and had a record attendance.

The program included an orchestra, a troupe of accordian serenaders, a magician, two dancers, six chorus girls, and a mistress of ceremonies. The party lasted until midnight.

Western New York

Plans for the first three business meetings of the 1935-36 season have been formulated by the Western New York Chapter. On October 14, 1935 a dinner meeting will be held at the Touraine Hotel when L. T. Avery, Cleveland, O., will speak on Air Conditioning. On November 11, 1935, Touraine Hotel, a prominent manufacturer will discuss the subject of New Developments in Heating Equipment. A Christmas Party at the University Club has been scheduled for December 23, 1935.

Secy. J. J. Landers reports that 74 members are on the Chapter membership roll and the following officers and committees are functioning:

President—W. E. Voisinet.
1st Vice-President—P. S. Hedley.
2nd Vice-President—B. C. Candee.
Secretary—J. J. Landers.
Treasurer—R. T. Thornton.
Board of Governors—M. C. Beman, *Chairman*, R. T. Coe, L. A. Harding, C. W. Farrar, W. G. Fraser, Roswell Farnham, J. J. Yager, M. S. Jackson, C. A. Evans, O. K. Dyer, F. H. Burke, Joseph Davis and D. J. Mahoney.
Program Committee—M. C. Beman, *Chairman*.
Entertainment Committee—Joseph Davis, *Chairman*.
Membership Committee—B. C. Candee, *Chairman*.

A synopsis of meetings held during the past season is included in the annual report of the Chapter.

October 8, 1934. Speakers: E. G. Speyer, consulting engineer for the Buffalo Planning Board. Subject: Water Front Development and Major Street Plans. Mr. Wilson, Buffalo Chamber of Commerce; Mr. Gertis, Federal Housing Administrator. Attendance—25 members and guests. Touraine Hotel.

November 12, 1934. Speaker: J. J. Nesbitt, Jr., Philadelphia, Pa. Subject: A Thermal System of Ventilation Control. Attendance—32 members and guests. Touraine Hotel.

December 17, 1934. Christmas Party and social evening. Attendance—38 members and guests. University Club, Buffalo, N. Y.

January 14, 1935. Speaker: Prof. L. G. Hector, University of Buffalo. Subject: Television. Attendance—45 members and guests. Touraine Hotel.

February 11, 1935. General forum and informal discussion. Attendance—25 members and guests. Touraine Hotel.

March 11, 1935. Speaker: L. P. Saunders. Subject: Radiator Developments. Attendance—32 members and guests. Touraine Hotel.

April 9, 1935. Speaker: John Howatt, Chicago, Ill., president of the A.S.H.V.E. Subject: Our Position Today. Attendance—52 members and guests. Touraine Hotel.

May 13, 1935. Speaker: W. L. Fleisher, consulting engineer, New York, N. Y. Subject: Research and Its Effect on the Material Requirements of Air Conditioning. Attendance—65 members and guests. Touraine Hotel.

Ontario

A golf meeting at the Weston Golf and Country Club, followed by dinner at the clubhouse, is scheduled for the October 7, 1935, meeting of Ontario Chapter. Other plans include a meeting on November 4 at the Royal York Hotel, when the subject of Automatic Control will be discussed and the coffee talk will be given by E. R. Gauley on Scale Boys. On December 2, a meeting at the Royal York Hotel will have Prof. E. A. Allcut, University of Toronto, as speaker on Heat Insulation.

The officers and committees of the Ontario Chapter for the year 1935-36 are:

President—M. W. Shears.
Vice-President—Thomas McDonald.
Secretary-Treasurer—H. R. Roth.
Board of Governors—H. D. Henion, G. A. Playfair, H. B. Jenney, and W. R. Blackhall.
Program Committee—M. W. Shears, *Chairman*, and members of the Board of Governors.
Attendance Committee—J. S. Wood, *Chairman*, E. T. Flanagan, H. B. Jenney, W. C. Kelly, D. I. Paul, E. Fox, J. H. Fox, J. W. O'Neill and C. D. Waldon.
Membership Committee—M. F. Thomas, *Chairman*, A. H. Hills, R. G. Heard, D. O. Price and A. G. Ritchie.
Greeters Committee—H. H. Angus, *Chairman*, W. P. Boddington, O. L. Maddux and W. R. Blackhall.
Entertainment Committee—E. R. Gauley, *Chairman*, L. L. Anthes, J. S. Paterson, A. Wardell and T. G. Jeffrey.
Auditors—F. E. Ellis, *Chairman*, and G. E. Cole.

Meetings held during the 1934-35 season at the Royal York Hotel have been outlined in the annual report submitted by Secy. H. R. Roth. The Chapter numbers 75 on its membership roll.

October 1, 1934. Attendance—29 members and guests. O. L. Maddux spoke on The Romance of Gas. D. O. Price discussed Air Conditioning.

November 5, 1934. Attendance—36 members and guests. An address on It Pays to Be Modern was given by J. Keenan.

December 3, 1934. Attendance—61 members and guests. E. T. Whittall spoke on Oil Burner Units and was followed by the principal speaker, Prof. E. A. Allcut, who discussed Design and Development of Concealed Heaters.

January 7, 1935. Attendance—44 members and guests. George Crawford was the principal speaker, talking on Plumbing Fixtures, Past and Present.

February 4, 1935. Attendance—42 members and guests. W. C. Kelly spoke on Boilers and Boiler Settings.

March 4, 1935. Attendance—64 members and guests. The principal speaker was E. D. Milener, *American Gas Association*, who gave An Hour's Discussion on Gas Heating and Year Around Air Conditioning.

April 8, 1935. Attendance—44 members and guests. Pres. John Howatt of the A.S.H.V.E., Chicago, Ill., was the guest of honor and spoke on Our Position Today. Prof. Robert Angus, University of Toronto, gave a coffee talk on Preparing Men for the Engineering Profession.

May 13, 1935. Attendance—43 members. This was the annual meeting, at which the election of officers was held, followed by a social evening.

Pittsburgh

Programs of meetings to be held during the remainder of 1935 have been outlined in the annual report prepared by Secy. T. F. Rockwell. At the October 14 meeting, the president of the A.S.H.V.E., John Howatt, Chicago, Ill., will be the guest of honor and speaker. The subject of Reversed Refrigeration Cycle will be discussed at the meeting on November 11. The program for the December meeting, which heretofore has been the annual meeting, will not be planned until the chapter decides on amendments of the By-Laws to conform to the action of the Council in June 1935.

The membership of the Pittsburgh Chapter is divided into the following classifications: Members—34; Associate Members—6; and Junior Members—2. The officers and committees in charge of activities are:

President—L. B. Pittock.
Vice-President—R. J. J. Tennant.
Secretary—T. F. Rockwell.
Treasurer—H. A. Beighel.
Board of Governors—P. A. Edwards, C. M. Humphreys and F. H. Hecht.
Program Committee—J. F. Collins, Jr., *Chairman*, W. H. Osterle, M. L. Carr.

Membership Committee—E. C. Smyers, *Chairman*, H. B. Steggall, L. S. Maehling.

Attendance Committee—R. J. J. Tennant, *Chairman*, A. F. Giles, R. B. Stanger.

A resumé of meetings held during the past season is given:

January 14, 1935. Place—Auditorium, U. S. Bureau of Mines. Speaker—D. P. Hartson. Subject—Production and Distribution of Natural Gas. Attendance—16 members and 19 guests.

February 11, 1935. Place—Pittsburgh Post Office and Federal Court Building, and the new studios of radio station KDKA in the Grant Building. Program—Inspection trip. Attendance—35 members and 90 guests.

March 11, 1935. Place—Auditorium, U. S. Bureau of Mines. Speaker—G. S. McEllroy, consulting engineer. Subject—Fundamentals of Air Conditioning. Attendance—22 members and 50 guests.

April 15, 1935. Place—Auditorium, U. S. Bureau of Mines. Program—Report of Committee on Proposed Code for Heating and Ventilation of School Buildings in the Commonwealth of Pennsylvania, followed by a discussion. Attendance—16 members and 4 guests.

May 13, 1935. Place—Pittsburgh Testing Laboratories. Program—Buffet supper as guests of the laboratory, followed by an inspection trip. Attendance—23 members and 14 guests.

Philadelphia

The Philadelphia Chapter has completed a satisfactory year and arrangements have been made for the first three meetings of the 1935-36 season, at the Engineers Club. Opening with the October meeting, a talk will be given by C. F. Mowrey, Oswego, N. Y., on Heating by Reversed Refrigeration Utilizing Gas. The November meeting will be given over to the reading and discussion of a paper prepared by the Society's Research Laboratory on Study of Summer Cooling Standards. Tentative arrangements have been made for a talk on Certain Phases of Air Conditioning by C. S. Leopold, consulting engineer, in December.

The annual report of Secy. H. H. Erickson states that the Chapter has an enrollment of 112 members and 5 juniors and the following list gives the Chapter officers and committees:

President—J. H. Hucker
Vice-President—W. R. Eichberg (*deceased*)
Secretary—H. H. Erickson
Treasurer—L. P. Hynes
Board of Governors—W. P. Culbert, S. E. Plewes, R. F. Hunger

COMMITTEES

Meetings
(*Includes Publicity Committee as Sub-Committee*)
S. E. Plewes, *Chairman*
A. C. Caldwell
W. F. Smith
P. L. Davidson
Morris Sheffler

Finance
W. F. Smith, *Chairman*
A. J. Nesbitt
Alexander McClintock, Jr.

Legislative
L. C. Davidson, *Chairman*
F. D. Mensing (*2 years*)
M. F. Blankin (*3 years*)

Membership
R. F. Hunger, *Chairman*
J. D. Cassell
G. W. Barr
H. P. Gant
F. D. Mensing
R. C. Bolsinger
Benjamin Adams
H. G. Black
L. C. Davidson
M. F. Blankin
W. P. Culbert

Attendance
(*Membership Sub-Committee*)
A. H. MacDade, *Chairman*
J. L. Clodfelter

Year Book
A. E. Kriebel, *Chairman*
H. H. Erickson

The Chapter was fortunate in having some excellent papers presented during the past year and a synopsis of meetings, which were held at the Engineers Club with the exception of the May meeting, is given.

October 11, 1934. T. N. Adlam presented a paper on Panel Heating, illustrated with slides. Attendance—65 members and 10 guests.

November 8, 1934. Benjamin Adams ably described a new ventilating fan. L. H. Plum talked on Some New Types of Controls Used for Various Purposes, and A. D. Harvey discussed the subject of Something New in a Vacuum Pump, illustrated with slides. Attendance—60 members and 15 guests.

December 13, 1934. W. J. Burke gave an illustrated talk on Bright Metallic Surface as Insulation. Attendance—55 members and 8 guests.

January 10, 1935. The annual meeting was held and after the business of the evening, an enjoyable entertainment was furnished. Attendance—80 members and 25 guests.

February 14, 1935. A paper on an Air Conditioning Unit Embodying Cooling and Heating by Refrigeration was given by H. L. Galson and illustrated with slides. Attendance—58 members and 10 guests.

March 14, 1935. A two-reel talking picture depicting several phases of the commercial side of the oil and gas business was presented by R. E. Jones. This was an interesting talking picture and was well received. Attendance—62 members and 11 guests.

April 11, 1935. The Chapter was honored by having Pres. John Howatt of the A. S. H. V. E., Chicago, Ill., as guest and speaker. President Howatt gave a very interesting talk which was enjoyed by the 65 members and 12 guests present.

May 9, 1935. The last meeting until fall was held at the Roxborough Country Club, where a golf tournament preceded the business meeting. The Nominating Committee was elected and after a very short business session, the evening was devoted to the pleasure of the members and guests. Attendance—60 members and 25 guests.

St. Louis

In the annual report of the St. Louis Chapter, Secy. A. L. Walters states that the Chapter membership includes 32 Members and Associate Members, 3 Junior Members and 5 Limited Chapter Members.

The officers and committees serving the Chapter are:

President—J. W. Cooper.
Vice-President—C. R. Davis.
Vice-President—G. W. F. Myers.
Secretary—A. L. Walters.
Treasurer—E. E. Carlson.
Board of Governors—Paul Sodemann, C. E. Hartwein, D. J. Fagin, E. A. White.

COMMITTEES

Program
G. W. F. Myers, *Chairman*
W. C. B. Sodemann
H. W. McLarney
R. J. Tenkonohy
F. B. Fillo

Entertainment
E. E. Carlson, *Chairman*
J. E. Manahan
L. R. Szombathy
D. J. Fagin

Publicity
D. J. Fagin, *Chairman*
J. E. Hamilton
T. W. McMahon

Auditing
C. E. Hartwein, *Chairman*
L. W. Moon
E. A. White

Membership
L. W. Moon, *Chairman*
C. R. Davis
J. M. Foster
G. L. Ranck
R. R. Clegg

Educational
C. R. Davis, *Chairman*
Paul Sodemann
P. L. Reed
G. B. Rodenheiser

Associated Engineering Society
J. W. Cooper, *Chairman*
Paul Sodemann, *Alternate*
R. M. Rosebrough, *Counselor*
E. P. Bradley, *Counselor*

Employment Officer
E. A. White

A synopsis of meetings follows:

September 19, 1934. J. W. Cooper, Chairman of the Program Committee, led a very interesting discussion of THE 1934 GUIDE. Attendance—28.

October 17, 1934. J. L. DeNeille, president of the *Heating, Piping & Air Conditioning Contractors National Association*, discussed the F.H.A. Program and N.R.A. Codes and means for making them effective locally. Attendance—17.

November 8, 1934. Joint meeting with the Engineers Club. Pres. A. C. Willard, University of Illinois, a past president of the Society, spoke on Air Conditioning for Human Comfort. Attendance—500. Preceding the joint meeting, President Willard met with the A.S.H.V.E. Chapter at its business dinner meeting and gave a brief address.

December 5, 1934. The Use of Gas for Heating was the sub-

ject of D. J. Fagin, heating engineer. The installation of officers also took place. Attendance—27.

January 8, 1935. A. J. Lindsay was the speaker on Oil Burners and their Application to Air Conditioning Units. Attendance—27.

February 12, 1935. Air Conditioning Railway Cars was discussed by H. D. Euwer. Attendance—30.

March 6, 1935. John Howatt, Chicago, Ill., president of the A.S.H.V.E., was the guest of honor and spoke on Our Position Today. Attendance—25.

April 2, 1935. Selling Air Conditioning was the title of a talk by H. W. Buschman. Attendance—36.

May 14, 1935. Compressors and Expansion Valves and their Application to Air Conditioning was discussed by W. C. Chapman. Attendance—28.

June 8, 1935. A dinner dance was held at Norwood Hills Country Club. Attendance—90 members and guests.

In addition to the regular meetings, the Chapter again cooperated with the David Ranken, Jr. School of Mechanical Trades in the second Open Forum on Air Conditioning for Comfort. A series of 7 weekly meetings were held from January 14 to February 28 and the total attendance was 3,205. Topics of discussion were led by forum leaders, who gave illustrated talks covering the subjects, after which the meetings were open for general discussion.

Southern California

The Southern California Chapter has 40 members on its membership roll and the following officers and committees are in charge of activities:

President—W. E. Barnum.
Vice-President—Leo Hungerford.
Secretary—P. C. Scofield.
Treasurer—A. G. Orear.
Board of Governors—W. H. C. Ness, E. H. Kendall, W. W. Pierce, H. L. Warren.
Membership Committee—W. E. Cranston.
Program Committee—Leo Hungerford.

An outline of meetings held during the past season is given in the annual report prepared by Secretary Scofield.

November 1934. R. E. Phillips, consulting engineer, discussed problems connected with the design and construction of the Los Angeles Aqueduct. The annual election of officers was also held. Attendance—40.

December 1934. Arthur Hess spoke on Comfort with Relation to Heating, Ventilating and Air Conditioning. Attendance—17.

January 1935. R. L. Stanley and W. E. Campbell discussed Gas Furnaces and Hot Water Heating. Attendance—22.

February 1935. Walter Bantau spoke on The Operation and Maintenance of Air Conditioning Systems. Attendance—60.

March 1935. Pres. John Howatt of the A.S.H.V.E. was the speaker and his subject was Society Activities. Attendance—75.

April 1935. H. H. Douglass discussed the Relation between Power Companies and Manufacturers. Attendance—30.

May 1935—V. Witkin described Engineering in Russia. Attendance—30.

Wisconsin

Activities of the Wisconsin Chapter began early in the fall with a meeting on September 18 at which new officers were elected and installed and discussion and ratification of a constitution for the Chapter took place. A talk on Engineering in Telephone Exchanges is scheduled for October 14. A joint meeting with Illinois Chapter will be held in Milwaukee on November 18 and will include an inspection tour of the A. O. Smith plant. Two technical papers will be provided by each chapter.

Secy. R. G. Koch has prepared the annual report and 46 members are on the Chapter's roll. The following officers were elected at the September meeting and committee appointments will soon be made:

President—C. H. Randolph
1st Vice-President—A. M. Wagner
2nd Vice-President—M. E. Erickson
Secretary—R. G. Koch
Treasurer—W. H. Wilson
Board of Governors—G. L. Larson, J. S. Jung, Ernest Szekely.

Meetings held during the past season consisted briefly of:

September 24, 1934. Election of officers. Ernest Szekely presented a short informal paper on Silica Gel. Attendance—9.

October 23, 1934. Discussion of the State Heating and Ventilating Code led by J. G. Shodron. Attendance—14.

November 26, 1934. Prof. G. L. Larson gave a talk on the Results of Research on various Methods of Heating an Industrial Type of Building. Attendance—17.

December 17, 1934. A paper entitled Electric Motors and Their Application was given by C. F. Hosstetter. Attendance—11.

January 21, 1935. H. R. Linn, Chicago, Ill., addressed the meeting on the subject of The Heating Salesman. Attendance—10.

February 18, 1935. A letter from Pres. John Howatt was read. L. A. Burch led a discussion on the first chapter in THE A. S. H. V. E. GUIDE. Mr. Rogers presented a paper on the Development of Water Supplies from Deep Wells Attendance—16.

March 19, 1935. President Howatt's letter on Research was read. Reports were given on the revision of the Wisconsin Heating and Ventilating Code and on the Society's Cooperative research work with Marquette University. The guest of honor, Pres. John Howatt, Chicago, Ill., delivered a talk on Our Position Today. Attendance—20.

April 16, 1935. C. H. Randolph gave a synopsis of Chapter 2 of THE A. S. H. V. E. GUIDE. Oil Burners was the title of a talk by H. Frentzel. Attendance—24.

May 20, 1935. B. P. Fonda, Cleveland, O., told the story of Air Conditioning with Silica Gel. Attendance—63.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 16 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by October 15, 1935, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
BAKER, H. L., Jr., Sales Engr., American Blower Corp., New York, N. Y.	Arthur Ritter F. R. Still	R. G. Olson H. R. Denny
BERNHARD, GEORGE, Managing Engr., Associated Htg. Co., Brooklyn, N. Y. *(Advancement.)*	M. W. Ehrlich F. W. Phillips, Jr.	A. B. Gilmour H. R. Birch *(Non-Member)*
CHAPIN, H. G., Air Cond. Engr., York Ice Machinery Corp., Chicago, Ill.	L. J. Pitcher J. F. Hale	F. C. Warren J. H. O'Brien
GILES, J. C., Student, University of Oklahoma, Norman, Okla.	E. F. Dawson Joseph Liston *(Non-Member)*	Bennie Shultz *(Non-Member)* W. H. Carson *(A. S. M. E.)*
HARTIN, W. R., JR., Htg. Engr., W. R. Hartin, Columbia, S. C.	F. D. Rodgers *(Non-Member)* Robert Lafaye *(Non-Member)*	W. B. Shirley *(Non-Member)* D. H. Shenk
HAUS, I. J., Commercial Engr., Morley-Murphy Co., Milwaukee, Wis.	C. H. Randolph H. F. Hutzel	G. L. Larson Ernest Szekely
HAWKINSON, C. F., Engr., U. S. Air Conditioning Corp., Minneapolis, Minn.	L. P. Hanson J. R. Hall	H. E. Gerrish A. B. Algren
HERING, ALFRED, Htg. Contractor, Hering Htg. Co., Inc., New York, N. Y.	W. R. Zuhlke W. W. Timmis	F. B. Campbell O. O. Oakes
JONES, N. R., Sales Mgr., Orr & Sembower, Inc., Reading, Penna.	E. N. McDonnell A. E. Kriebel	M. F. Blankin W. P. Culbert
KENT, R. L., Dist. Mgr., Trane Co. of Canada, Ltd., Winnipeg, Man., Can.	C. H. Turland E. T. Summers	J. B. Steele William Glass
LUND, C. E., Lab. Asst., University of Minn., Minneapolis, Minn. *(Advancement.)*	F. B. Rowley A. B. Algren	J. V. Martenis D. M. Forfar
MILLER, B. R., Design Engr. & Estimator, Renz Engrg. & Equip. Co., Oklahoma City, Okla. *(Advancement.)*	E. W. Gray S. L. Rolland	R. G. Dolan F. X. Loeffler
RYAN, J. D., Bldg. Mgr. and Engr., Whitney National Bank Bldg., New Orleans, La.	G. M. Mellinger *(Non-Member)* R. C. Watkins *(Non-Member)*	H. G. Martin *(Non-Member)* L. F. Alexander *(Non-Member)*
WATSON, H. D., Branch Mgr., Linde Canadian Refrigeration Co., Winnipeg, Man., Can.	C. H. Turland E. F. Munn	D. F. Michie William Glass
WILSON, ANDREW, Estimator & Supt., Montgomery Ward Co., Jamaica, L. I., N. Y.	C. B. Pinto *(Non-Member)* J. B. Brown *(Non-Member)*	H. L. Bernstein *(Non-Member)* Herman Ahlrich *(Non-Member)*
YOUNG, E. O., Pres.-Treas., The Young Vtg. Co., Cleveland, Ohio.	G. L. Tuve F. A. Kitchen	M. F. Rather E. J. Vermere

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

APT, SANFORD R., Mech. Engr., U. S. Government, Washington, D. C.

HOULIS, LOUIS D., Chief Engr., Master Baker Oven Mfrs., Cincinnati, Ohio.

KNOWLES, M. G., Instructor, Wentworth Inst., Boston, Mass.

LIGHTHART, CHARLES H., N. Y. State Engr., Lakeside Co., Buffalo, N. Y.

LONG, WAYNE E., Assoc. Prof. Mech. Engrg., Texas Agric. & Mech. College, College Station, Texas.

LYONS, MICHAEL A., Htg. Contractor, New York, N. Y.

SHERMAN, VICTOR L., Assoc. Prof. Mech. Engrg., Lewis Inst., Chicago, Ill.

SHOTWELL, R. W., Designing Engr., W. J. Spoelstra Co., Inc., Hawthorne, N. J.

SPOELSTRA, W. J., Pres., W. J. Spoelstra Co., Inc., Hawthorne, N. J.

THOMPSON, FRANK, Chief Draftsman & Engr., Vulcan Iron Works, Ltd., Winnipeg, Can.

ZIEBER, W. E., Mech. Engr., York Ice Machinery Corp., York, Penna.

ASSOCIATES

BLAKESLEE, DONALD, Engr., Donald Blakeslee, Patchogue, L. I., N. Y.

HARMONAY, WILLIAM L., Mgr., M. J. Harmonay, Yonkers, N. Y.

PONSELL, FRANCIS I., Sales Engr., James P. Ponsell & Sons, Wilmington, Dela.

ROSE, ARNOLD A., Sales Engr., Fitzgibbons Boiler Co., White Plains, N. Y.

SWANSON, EARL C., Research & Design Engr., Andersen Frame Corp., Bayport, Minn.

VARNER, JOHN L., Air Cond. & Comm. Engr., The Jacksonville Refrigeration Co., Inc., Jacksonville, Fla.

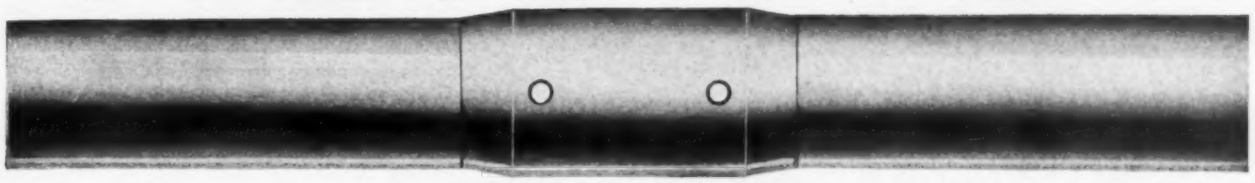
JUNIORS

LINDBERG, A. F., Asst. Archt. Engr., National Park Service, Omaha, Nebr. *(Advancement.)*

STUDENT

CLAY, CHARLES H., Student, Iowa State College, Ames, Iowa.

VIBRATION



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THERE are no threaded or flared joints to loosen by vibration in an installation of STREAMLINE Fittings and Copper Pipe.

Vibration is harmlessly dissipated over the entire system and not localized at threaded joints. The connection formed by a STREAMLINE Fitting is a leak, rust and vibration proof bonded joint of pipe, solder and fitting. (Microphotographs prove this beyond a shadow of a doubt). The joint in an installation of STREAMLINE materials instead of being the weakest point is actually the strongest.

Repeated tests run on a 10 ft. length of ¾ in. vertical pipe containing nine of the patented joints, in which the lower end was held rigid and the upper end attached to a vibrator running continuously, day and night, for one week, showed not the slightest sign of failure at any of the connections. The section of pipe was subjected to 850 vibrations per minute, totalling 8,568,000 vibrations over the week's period. (A severe test this—we believe you'll admit.)

Connections made with STREAMLINE Fittings to hard copper pipe have successfully withstood over 16,000,000 vibrations or tests run for aviation fittings. (Standard Aviation fittings fail, as a general thing, at less than 8,000,000 vibrations).

Absence of clogging and freedom from the harmful effects of rust and vibration are but a few of the many reasons why STREAMLINE protects the building owner from costly repair bills and gives him a trouble free conducting system as long as the building stands. It will pay you to investigate the possibilities of a modern STREAMLINE installation either for replacement or new work.

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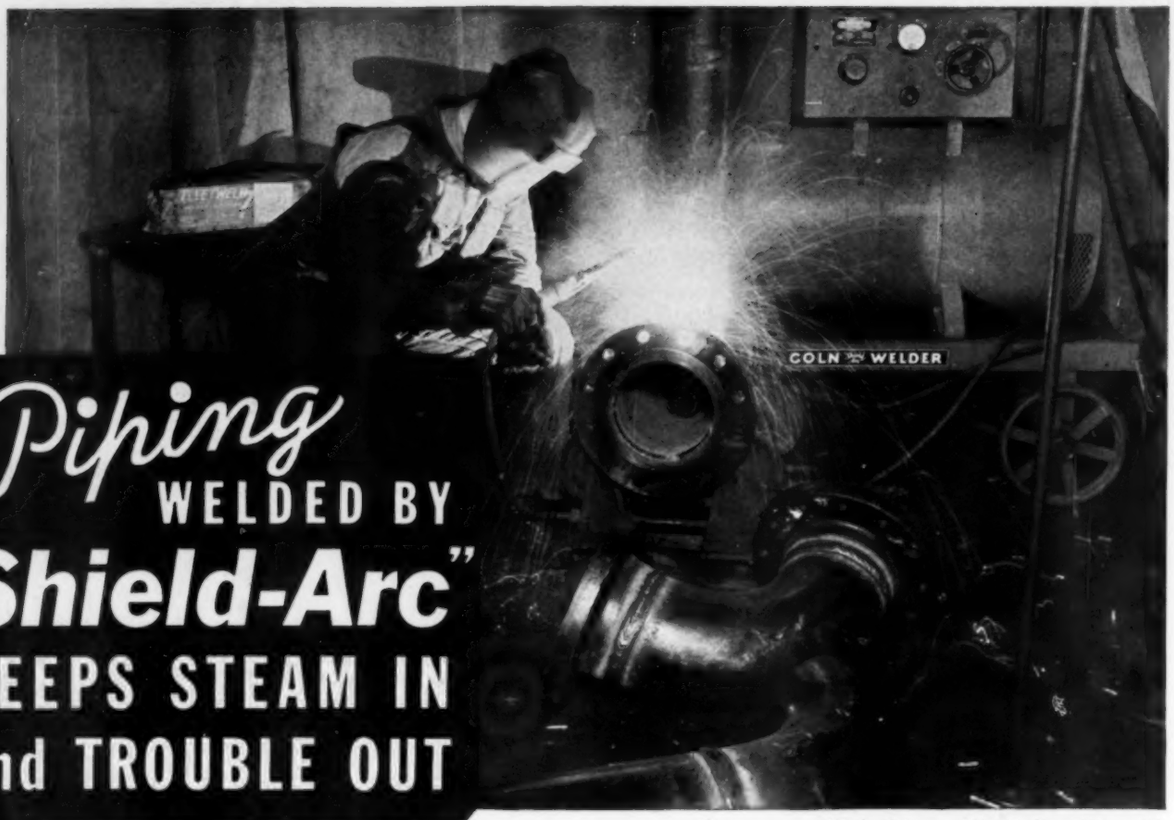

Piping WELDED BY "Shield-Arc" KEEPS STEAM IN and TROUBLE OUT

Photo courtesy of Federal Pipe and Supply Co., Chicago, Ill.

Once piping is welded by "*Shield-Arc*," it is forever leak-proof and trouble-free. Because the "*Shield-Arc*" welded joints are stronger than the pipe, equal to the pipe in ductility, greater in resistance to corrosion and as leak-proof as the pipe.

Is it any wonder that those who want longest, carefree piping operation, are erecting their new lines by "*Shield-Arc*" welding?

And quality combines with economy when you weld piping with a "*Shield-Arc*." For "*Shield-Arc's*" uniform current, high capacity and increased efficiency provide every last cent's worth of welding for every welding dollar. No other welder can equal the "*Shield-Arc*" in ability to weld highest quality pipe joints at lowest cost. Users claim the "*Shield-Arc*" 10% to 25% more economical than ordinary welders.

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Department RR-169, Cleveland, Ohio

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LAD: "Why be down in the mouth about things—it's a simple matter to get your face lifted."

POP: "But the trouble is to keep it that way when you read the news out of Washington. I wish they could give us permanence to any face lift the way *'Shield-Arc'* gives it to piping connections."

Burnham Boilers

The Burnham Twin Section 50-inch grate boiler, in its 9 sizes, has a steam rating of from 7850 to 19450 square feet.

The Burnham Welded Steel boiler made in 19 sizes with a steam rating from 1800 to 35000 square feet.

You May Call Us Names But You Can't Accuse Us of THIS

YOU can't accuse us of trying to sell you a cast iron boiler, when what you really should use is a steel. Or the other way around, either. You can't, simply because Burnham doesn't do business that way.

Some 70 years or so ago, Mr. Burnham figured out that one of the ways to stay in business and make a dollar now and again, was to give a man the best thing for his particular needs. If you didn't have that best thing, then be frank about it.

In those days we made only cast iron boilers. But for many a year now, we have had our own separate welded steel boiler plant. Whichever boiler best meets your needs, that is the boiler we most want to sell you.

Having made boilers the best we knew how, for all these years, we have a feeling that Burnhams are well worth the money asked. Might even go so far as to say, they had some points that we think makes them better boilers than others.

But supposing they were exactly the same. The fact of their being made by Burnham doesn't exactly hurt them, wouldn't you say?

All right then, next time you want a boiler, it might be a smart thing to drop us a line and see how near to the truth our views on Burnhams are. Get the facts. See for yourself.

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IRVINGTON, NEW YORK

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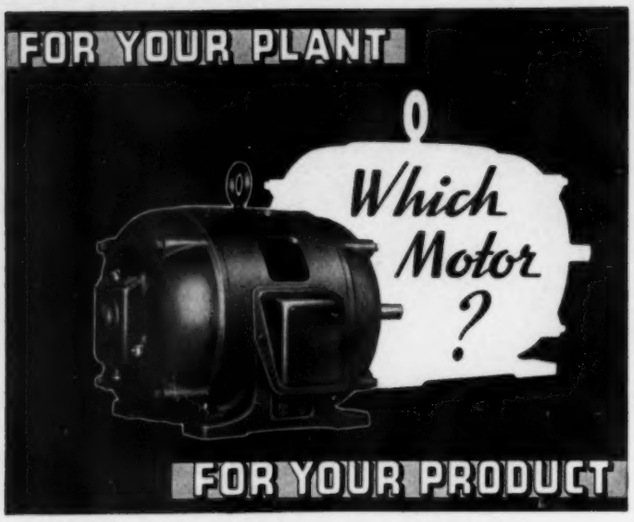

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The benefits of equipping your product or plant with Century Motors result from:

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Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 103 . . . Add the new products and companies listed here to your Directory Section which you received in your January 1935 Heating, Piping and Air Conditioning and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

New Dehumidifying Unit

No. 372—**New gas operated, direct dehydrating unit ("Kathabar") for removing moisture from air at room temperature makes use of a liquid drying agent (lithium chloride, named "Kathene) which has high moisture absorption characteristics. Available in four sizes (500, 1000, 2000, and 4000 cfm) it is recommended by the manufacturer for both industrial processing and comfort air conditioning applications. Unit circulates, washes, dries, cools (in conjunction with low temperature tap or well water, or refrigerating equipment), heats and humidifies.

Operation is as follows: Hot, moist air is passed through a drying chamber in direct contact with the cool "Kathene" liquid which removes moisture from the air at the same time it cools and cleans it. The air then passes to the conditioned space. The solution, having absorbed moisture, is circulated through a regenerator circuit where the moisture is driven off to an air circuit leading outside the building, when it is ready for further use.—Surface Combustion Corp., 2375 Dorr St., Toledo, Ohio.

Zoned Controlled Heating; Venting Valves

No. 373—It has been announced that the Hoffman Specialty Co., Inc., Waterbury, Conn., has acquired the patents of the Webster Tallmadge Co., East Orange, N. J., and will hereafter manufacture, sell and engineer the "Hoffman-Tallmadge" system of zoned controlled heat; and that Mr. Webster Tallmadge has become associated with the Hoffman organization.

This system, which incorporates a number of departures from other methods, operates on the principle that large amounts of steam can be saved by eliminating the overheating of buildings. Three types of controls are correlated to achieve this end: (1) Zoning of radiation in accordance with the demands of occupancy, exposure and altitude; (2) accurate control of steam supply to the heating zones. The system modulates or graduates the steam to each zone separately; and (3) precise orifice distribution of steam to radiators, so that both far and near radiators are heated uniformly, regardless of whether little or full heat is required to obtain proper comfort. Orifices are made with precision for each size of radiator, but are usable in any radiator of that size, regardless of location in the system.

System is available in a number of different types, such as thermostatically controlled, centralized remote controlled, or manually controlled by modulating zone control valves or modulating boiler regulators in various arrangements. These controls are suitable for all sources of steam, supplied at any pressure. Returns are maintained at atmospheric pressure.

It has also been announced that the W. A. Russell Co., manufacturers of "Warco" air valves, have granted an exclusive license to the Hoffman Specialty Co. for all rights on adjustable port venting valves as covered by the former company's Patent No. 1,761,685. Under a cross-licensing agreement, the Hoffman company has in turn given an exclusive license to the Russell company for manufacturing rights under certain of their patents.

TUBE-TURNS* NEVER MISS!

IN welding especially, "a miss is as good as a mile." An even minor mis-alignment between pipe and fitting can *increase* the cost and *reduce* the strength of the joint.

Tube-Turns line up perfectly with the pipe—match it in O. D., I. D. and wall-thickness *at all points*. And this is true even if you cut the Tube-Turn to make an odd-angle turn.

No, you cannot get this advantage in any other fitting for welding . . . it's true only of the *pioneer* fittings made exclusively by Tube-Turns, Incorporated, Louisville, Ky.

★ The word "Tube-Turn" is NOT a general name for welding fittings. Tube-Turns are THE seamless fittings having uniform wall-thickness at all points, true circular cross-section, uniform radius of curvature and smooth inner walls. Made ONLY by Tube-Turns, Incorporated.

JUST TWO WIRES

Telemetering measurements of steam pressure, temperature or flow from the distant point to central headquarters requires only a simple two wire circuit. This is a particularly outstanding feature of Bristol's Metameter Long Distance System. And it holds good even if the measurements are made thousands of miles away.

Any existing telephone line may be used without danger of interference with or from the conversation carried.

Readings are translated by the transmitter into a time interval. This timed impulse is sent over a two wire line and retranslated back to the original unit of measurement at the receiver. The intensity, value and strength of the impulse do not enter into the recorded reading. For this reason Metameter indications are accurate. They are unaffected by neighboring inductance or capacity.

Right: Transmitter Model M35T of Bristol's Metameter Long Distance Pressure, Liquid Level, Temperature and Motion Electric Transmitting and Recording System.

Write for Bulletin 424.

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FOR TELEMETERING

Corrosion Control in Brine Systems

No. 374—Sodium chrom glucosate (alkaline organic chromate for control of corrosion in brine systems, condenser systems, and other aqueous systems where water is not used for human consumption) provides efficient corrosion control in brine systems between a pH of 6 and 12.

This alkaline chromate requires no adjustment before introduction and may be used safely in open systems without the development of chrom itch, states the maker. Available in 150, 300, and 500 lb drums.—D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill.

New Phase Rotation Indicator

No. 375—New type of phase rotation indicator with no moving parts weighs but 12 oz, has over-all dimensions of 5½ by 3½ by 3 in., is useful in three phase testing and installation work, such as the testing and installation of three phase meters and motors. It employs two neon glow lamps and a simple circuit which requires no adjustment. Suitable terminals are provided for connection to 110, 220, or 440 volt circuits. Pressing a centrally located button lights both of the glow lamps. The button is then released, and phase-rotation, clockwise or counterclockwise, is shown by which one of the lamps remains lighted.—General Electric Co., Schenectady, N. Y.

Stainless Steel Welding Rod

No. 376—New stainless steel welding rod for welding chrome-nickel steels of the 18-8 type is known as "Oxweld No. 28" columbium-treated 18-8 welding rod. Products fabricated from "treated" or "stabilized" 18-8 steel by welding with this rod have full corrosion resistance and heat resistance in the as-welded condition and no heat-treatment after welding is necessary, says the maker. Use requires no special technique other than that usually employed in welding stainless steel.—Linde Air Products Co., 205 E. 42nd St., New York, N. Y.

Rotary Pumps for Process Liquids

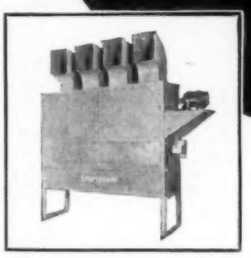
No. 377—Heavy duty rotary pumps for efficiently pumping practically all kinds of clean liquids (thin, thick, viscous, hot, cold, corrosive) not easily handled by other types of pumps, including those that solidify when cool, such as asphaltum, rosin, lard, soap, etc., are made in standard and steam jacketed types to handle pressures up to 300 lb per sq in., temperatures up to 650 F, with capacities of from 10 to 2500 gpm.

For viscous and solidifying liquids the pumps are steam jacketed. For high temperatures the stuffing boxes are water jacketed. Internal sleeve and internal roller bearings are used for non-corrosive liquids; external ball bearings for corrosive liquids. Continuous-tooth double-helical gear rotors eliminate end thrust. are mounted on stiff shafts with large, high-capacity bearings. The pumps give straightway, continuous, non-churning and non-foaming discharge, states the manufacturer.—Worthington Pump and Machinery Corp., Worthington Ave., Harrison, N. J.

Wear Resisting Welding Cable

No. 378—New type of welding cable designed to meet conditions of extremely severe wear and abrasion and known as "Realwear" consists of fine tinned copper wire laid in ropes and stranded. Individual ropes are alternated in succession as regards the direction of the lay to prevent distortion in applications of severe usage. Conductor is insulated with especially developed rubber compound, and high grade cotton woven on a loom and securely joined to the rubber belt by a special process forms the cover, which is provided with a finish resistant to oil, grease, acid, gasoline, moisture and heat.

Speed Heaters WON'T LEAK!



◀ Rexvane Heaters
For floor, wall or ceiling installation. Built in a wide variety of types and sizes ranging from 100,000 to 1,000,000 B.T.U.

... Not even with 200 lbs. steam pressure. They're guaranteed for that and have successfully withstood much higher pressures.

In addition, they are...

● QUICKLY, EASILY INSTALLED
Steam supply and return connections are provided on both *sides* of the heater.

● PROVIDE MAXIMUM HEADROOM
A big advantage where headroom is limited. Can be placed against the ceiling if necessary.

● CAN BE SHIPPED AT ONCE
Most popular voltages are stocked in many locations.

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New York, 420 Lexington Ave. Chicago, 400 N. Michigan Ave.
San Francisco, 681 Market St. *Branches in Other Cities*

B. F. STURTEVANT CO. of CANADA, Ltd., GALT.
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- ☐ Send me Suspended Type Speed Heater Catalog No. 396.
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Sturtevant® Speed Heaters

Supplied in sizes 2, 1, 0, 00, 000, and 0000, as follows:

Size	No. of strands	Sizes strands	O. D. Inches
2	1666	No. 34	0.617
1	2107	No. 34	0.728
0	2646	No. 34	0.775
00	3332	No. 34	0.827
000	4214	No. 34	0.884
0000	5242	No. 34	0.965

—Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio.

Automatic Controller Improved

No. 379—New "Tag No. 40" controller has been redesigned for compactness in such a fashion that the few simple parts are easily accessible and tube systems can be interchanged with facility, states the maker.

Spring lever designed to eliminate lost motion multiplies the movement of the capsular spring for sensitive yet positive control. Change in temperature is transmitted to the ball air valve which in turn resets the rate-of-flow through the diaphragm actuated control valve.

Indicating and non-indicating types in nine convenient temperature ranges and three pressure ranges are available.—C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.

Heavy Duty Welders

No. 380—Improved 200, 300 and 400 amp heavy duty arc welders include new oversize, two bearing armature shaft, removable ball bearing capsules, simplified single current control, dustproof calibration plate, heavy duty built in polarity switch and drip proof housings.

Motors have solid cast frames with top opening for terminal leads and mounting of the magnetic switch type starter; equipped with no-voltage release and overload protection operated by push buttons. A constant flow of cooling air, circulated by aluminum fan between motor and generator, is discharged at the end of the all-welded generator housing. Connections are available for standard or special voltages of 2 and 3 phase, 60 and 50 cycles. Gasoline powered units in a wide variety of stationary and portable mountings also are included in the line.—Harnischfeger Corp., 4400 W. National Ave., Milwaukee, Wis.

Precision Valve Action Unit for Diaphragm Valves

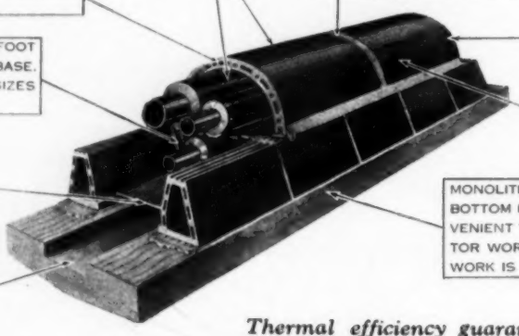
No. 381—For those control applications where load changes are not a problem but valve stem friction and diaphragm motor hysteresis must be overcome to obtain precision control, new "Valv-Precisor" has been developed as a separate instrument. The manufacturer states that, in general, any air-operated controller, with the aid of the device, can position the valve disc 50 times more accurately when opposed by valve stem friction and diaphragm motor hysteresis than when it is not used.

This device is recommended by the maker for all processes which have time lags or heat capacities demanding a low or medium controller sensitivity, provided that load changes are negligible or infrequent. It is unnecessary on processes with short time lags which permit a high controller sensitivity, and it should not be used on processes involving large time lags and load changes.

The unit is compact (case dimensions are 8x5x2 in.), may be mounted on any diaphragm valve and can be used in conjunction with any air operated controller. It must be so located on the diaphragm valve that a direct, rigid connection is maintained with the valve stem; a 25 lb per sq in. air or gas pressure is recommended for most efficient operation. A non-corrosive case and cover protect the mechanism. The only necessary adjustment is to adapt the mechanism to the full travel of the valve stem. An indicator which shows the actual percentage of valve opening is visible through a small glass window.—Taylor Instrument Companies, 95 Ames St., Rochester, N. Y.

STUDY THE MANY ADVANTAGES of THERM-O-TILE Reg U S Pat Off

The NEW Underground Steam Conduit System


PIPING AND CONDUIT ARE EACH INDEPENDENTLY SUPPORTED ON CONCRETE BASE
SEALED AIR CHANNELS IMPROVE EFFICIENCY OF INSULATING MEDIUM USED.
CAST IRON PIPE SUPPORTS ON 12 FOOT CENTERS RESTING ON CONCRETE BASE. SUPPORTS ADJUSTABLE FOR ALL SIZES AND COMBINATIONS OF PIPES.
ASBESTOS SEPARATOR PLATE FOR SUPPORT OF FIBRE INSULATION WHEN USED.
DRAINAGE SYSTEM ENTIRELY INTERNAL TO ASSURE PERMANENTLY DRY INSULATION SPACE AND TO CARRY OFF ANY SEEPAGE THAT MAY OCCUR IF ANY JOINT IS FAULTY. NO EXTERNAL DRAIN REQUIRED
ALL JOINTS SEALED TIGHT WITH WATERPROOF MORTAR LOCKED INTO CHANNELS IN TILE MEMBERS SMOOTH EXTERIOR PERMITS APPLICATION OF MEMBRANE WATERPROOFING FOR SUBMERGED LOCATIONS.
ARCHED CONSTRUCTION UNDER TEST SUPPORTS HEAVIER TRAFFIC LOADS.
CONDUIT MAY BE OPENED FOR PIPE REPAIR WITHOUT RENEWAL OF PARTS.
MONOLITHIC BASE POURED DIRECTLY ON TRENCH BOTTOM PROVIDES SOLID FOUNDATION AND CONVENIENT "SIDEWALK" ON WHICH PIPING CONTRACTOR WORKS WITHOUT INTERFERENCE UNTIL HIS WORK IS COMPLETED

Thermal efficiency guaranteed, under test, with either sectional pipe covering or fibre type insulation.

H. W. PORTER & CO., INC. 822-H Frelinghuysen Ave. NEWARK, N. J.

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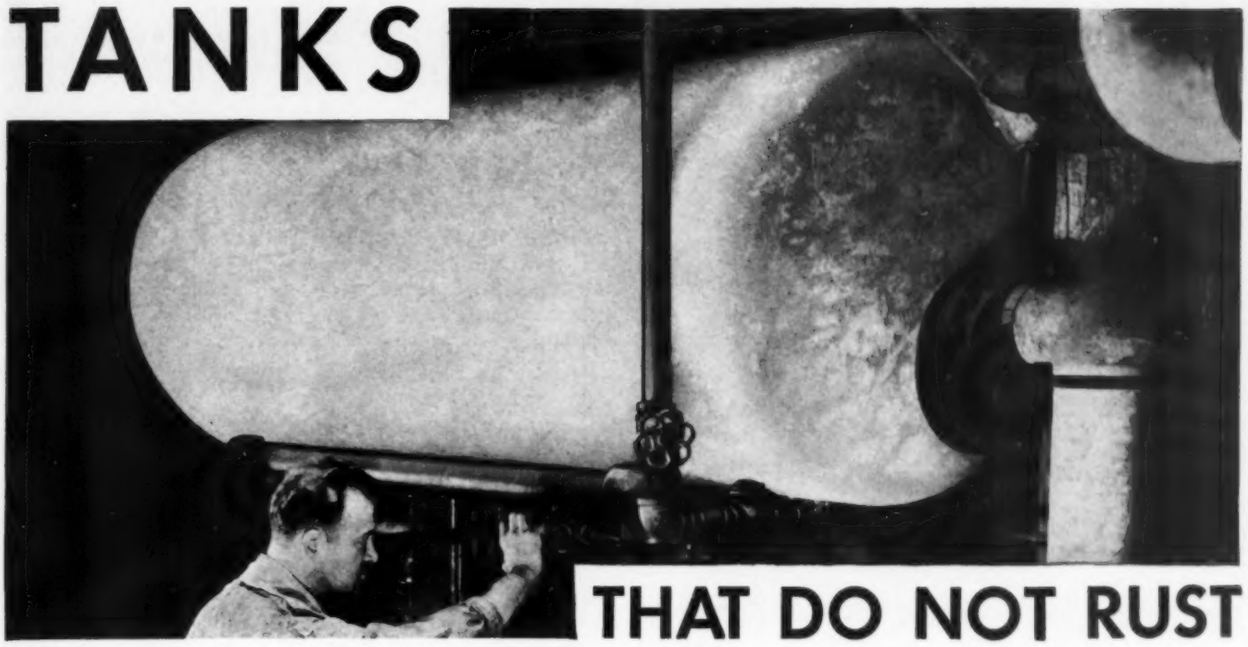

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DURONZE

RUSTPROOF Duronze steps into the front line when you call for a material with maximum strength *plus* the corrosion resistance of copper.

Duronze is as strong and tough as steel—therefore, sheets as thin as steel can be used with assurance of long life and safety under high pressures.

It is readily welded with the same equipment as used in steel welding—keeping fabricating costs down. Supplied in hot-rolled sheets of any desired thickness.

For hot-water storage tanks, big and little; for tanks in process industries; for ducts and flues, this Bridgeport silicon bronze (high-strength copper alloy) will save *first* costs and eliminate *replacement* costs.

IN LAUNDRIES

—for example—

Duronze-made tanks will solve special problems arising from excessive amount of *hot* water required and the *vital importance* of freedom from rust. Ordinary tank material leaves much to be desired. Non-rusting DURONZE tanks are recommended to laundries for a *long, trouble-free* life.

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For many years, Duronze has served various industries for cables, connectors and other uses. Samples and engineering data will be forwarded on request.

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Established 1865

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Use this BUYERS GUIDE TO SELECT YOUR UNIT HEATER

	Fedders Unit Heaters	Other Makes
Is the cabinet sturdy enough to protect heating element from piping stresses?	Yes	
Has it streamlined tubes brazed to headers?	Yes	
Is heating element free to expand and contract within cabinet?	Yes	
Is heating element capable of relieving differential expansion stresses within itself?	Yes	
Has the fan "graduated pitch" blades for quieter operation?	Yes	
Are the motors cushioned in a resilient mounting?	Yes	
Are they quieter in operation?	Yes	

All Unit Heaters are not alike. The Buyers' Guide shown above will help you check the features of Fedders Series 3 Unit Heaters.

FEDDERS *Series 3* UNIT HEATERS

are built as good as they look. They give you directed, effective heat when and where you want it. Bulletin 527 lists the complete line of twenty standard models. Send coupon for it today.

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57 Tonawanda Street, Buffalo, New York
Please send me Unit Heater Catalog No. 527.
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Concern .....
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Pipe Facing and Beveling Attachment

No. 382—New type of screwed joint employed in connection with heavy wall piping as used in oil refineries, chemical manufacturing plants, etc., is used on piping subject to high pressures and severe temperature changes. Joint has a Whitworth straight pipe thread and employs a gasket, requiring that, in addition to the thread cutting operation, the pipe be faced and beveled 20 degrees on the inside diameter and, further, that the pipe be recessed at the shoulder of the thread. A primary requirement is a smooth finish and concentricity of machined surfaces.

To combine the several machining operations with the cutting of the thread, a facing and beveling attachment for use on pipe threading and cutting machine has been developed. The attachment is equipped with adjustable cutting tools whose setting remains constant once properly adjusted, has a universal adjustment and will face and bevel all diameters of pipe within the range of the machine. Leadscrew provides positive feed to insure threads of correct form and lead, particularly important on the larger diameters since the threads are straight and not tapered as is the case with the ordinary screw joint, says the maker.

The pipe is completely machined at one chucking, including the threading, facing, beveling, and recessing operations.—Landis Machine Co., Waynesboro, Pa.

Flexible Couplings Improved

No. 383**—Changes in the design and materials of "Francke" flexible couplings have been announced. Flanges (except the larger sizes) are now made of a forged high manganese alloy steel; the larger sizes are molded of high grade semi-steel.

To prolong life of moving parts, self lubricating wax impregnated bronze bushings replace dry bushings. The new bushings have highly polished bearing surfaces to provide a large contact area, and due to the self lubricating feature, little resistance is offered to the endwise movement of the shafts of the connected machines when under load, says the maker.

Another improvement is in the design of the cross pin by which the crucible spring steel laminations are held within the keepers. The center portion of the cross pins which passes through the perforation in the lamination is now made glass hard. By a special process the ends of the cross pins are expanded into the tapered recesses of the keepers to make it impossible for them to become loose.—John Waldron Corp., New Brunswick, N. J.

Educational X-Ray Unit

No. 384—First "St. John" educational x-ray unit recently installed at the new Brooklyn technical high school consists of a heavy lead lined cabinet which encloses a standard 200,000 volt x-ray generator and air cooled tube. X-rays are permitted to escape from the cabinet only through a single window in the top, which is provided with a shutter, adjustable so that the area exposed to x-rays can be varied from zero to the full size of the window. A specimen box fits over the top of the base cabinet. Two doors in front and movable panels on top permit access to the interior for arranging objects to be examined. Safety devices are provided so that neither high voltage nor x-rays can be turned on while any access door or panel in either the base or the specimen box is open. A removable fluoroscope of special construction for indirect viewing of the x-ray image can be employed for certain teaching purposes. The space around the equipment can be darkened for visual inspection. Another feature of the installation is a pinhole instrument for high speed, high voltage x-ray diffraction analysis of metals—St. John X-Ray Service, Inc., 30-20 Thomson Ave., Long Island City, N. Y.

Motorized Variable Speed Transmission

No. 385—"P. I. V. Gear" variable speed transmission now furnished motorized (when desired), with motor forming an integral part of the unit; with or without speed reduction gearing; with horizontal or vertical box; and in 5 sizes up to 15 hp capacity, it has been announced; previously available in sizes up to but 10 hp with horizontal box only, and without reduction gear sets or the integral motor feature. Motorized construction makes a compact drive, eliminating need of separate motor base plate.

Operating principle of the basic unit remains the same as when introduced six years ago.—Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.

New Line of Water Heaters

No. 386—New line of hot water service and storage heaters built of "Everdur" are suitable, states the maker, for hotels, apartments, hospitals, schools, institutions and similar buildings where there is an intermittent demand for hot water, and are particularly desirable in laundries, textile mills, breweries and for other process work where water purity is important.

Shell and heads are of solid "Everdur" and all joints are electrically welded with "Everdur" welding rod. The flanged nozzle for the heating section is of "Everdur," electrically welded to the head. The heating surface is of 1¼ in. O.D. 16 B.W.G. pure seamless drawn copper U tubes rolled into a solid "Everdur" tube sheet. The steam chamber, which comes in contact with steam only, is cast iron.

The heating section is inserted into the nozzle, and the tube sheet and steam chamber are bolted to the nozzle flange with through bolts. The tubes are firmly supported in the shell by means of a copper tube support plate bolted to a copper cross bar, which is bolted to "Everdur" lugs welded to the inside of the shell.

Nominal storage capacities range from about 100 to 6000 gallons. Heating capacities (40 to 180 F, steam at atmospheric pressure) range from 100 to 10,000 gallons per hour.—Patterson-Kelley Co., Inc., East Stroudsburg, Pa.

Direct Fired Unit Heater for Plants

No. 387—New "Dravo" direct fired unit heater, designed for firing with oil, gas, coal, coke, or coke braize, is built of electrically welded steel. Lower part of combustion chamber is lined with insulating brick, and sides and top are of corrugated steel with welded fin deflectors on outer surface. An outer shell of copper bearing steel completely surrounds the sides and top, leaving an air chamber of proper proportions. Unit may be manually or automatically controlled.

Air emerges at the base of the unit in three horizontal streams for uniform distribution, and cold air is taken in from opposite side and along the floor. Where hot air discharge at floor level is objectionable, fans are located above combustion chamber so that hot air flows parallel to floor about 8 ft above it. Gases from the combustion chamber are removed with a small exhauster, maintaining the combustion chamber under a slight negative pressure.

Space requirements for the 750,000 Btu unit are about 5 ft by 8 ft by 10 ft high. In this unit a 5 hp fan delivers 10,000 cfm at 140 F; normal waste gas temperatures do not run over 500 F, states the maker.—Dravo-Doyle Co., Dravo Bldg., Pittsburgh, Pa.

Electric Unit Heaters

No. 388—Electric "Speed Heater," designed for installation where steam or hot water is not available, but where electric current can be used, has heating element consisting of extended surface strips combined as a single piece and with no exposed electric surface. Convenient terminals are provided inside the unit casing. A thermostatic element cuts off power in the event

IN ANY DIRECTION

WITH CERTAINTY

In the great transport plane of today, controls have been perfected by which the pilot can direct it in any direction with certainty.

For controlling the flow of forced air, Independent "Fabrikated" Adjustable Directed Air Flow Registers and Grilles are the latest development. In these, the grille bars can be easily adjusted, before or after installing, to direct air flows up or down, or right or left, to any angle up to 45 degrees.

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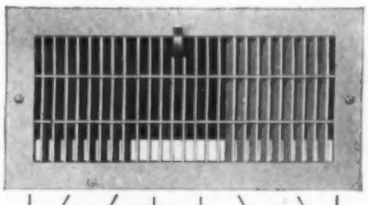

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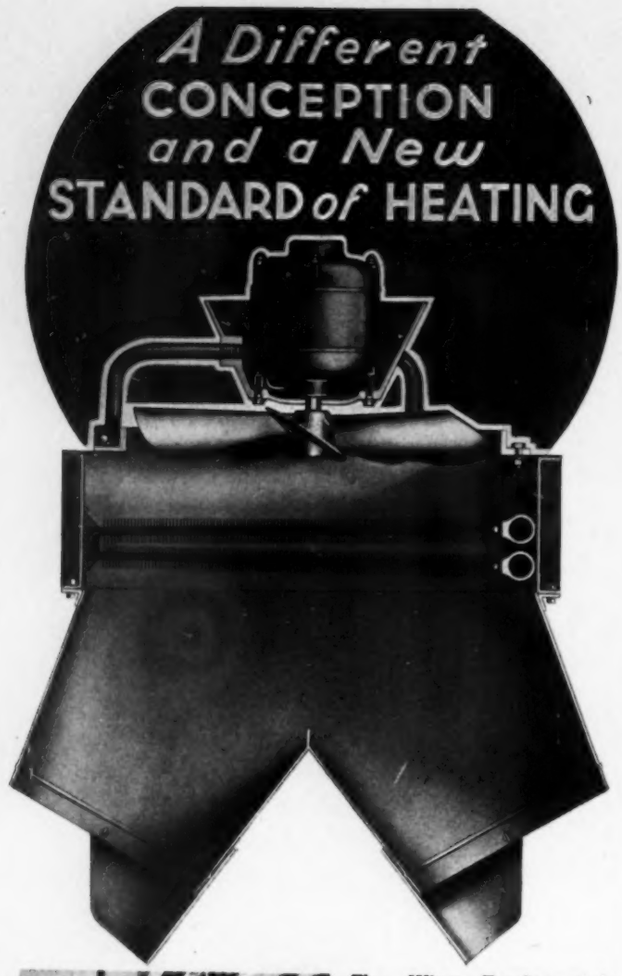
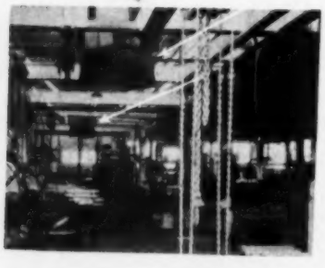
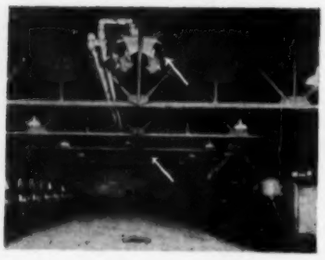




The Wing Featherweight Unit Heater works on an entirely new principle —

"A Flood-Light of Heat"

It is the scientific method of heating any size area economically and satisfactorily. The vertical downward discharge of the comfortably heated air is one of the exclusive features of the



WING FEATHERWEIGHT UNIT HEATER —

heating only that area where heat is actually needed, thereby assuring maximum bodily comfort, with highest possible economy and efficiency.

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L. J. Wing Mfg. Co.
14th Street and 7th Avenue
New York, N. Y.
and everywhere.

WING *Floodlight* HEATING

of motor failure, and has a convenient manual reset handle.

Capacities of the seven sizes range from 17,060 Btu per hr and 350 cfm to 136,480 Btu per hr and 1990 cfm.—B. F. Sturtevant Co., Damon St., Hyde Park, Boston, Mass.

Rotary Pipe Hole Saws

No. 389—New rotary saw for sawing pipe holes through wooden floors, ceilings and partitions comes in four sets—No. 1, for ¾, 1, and 1¼ in. pipe; No. 2, for 1, 1¼ and 1½ in. pipe; No. 3, for 1, 1¼, 1½ and 2 in. pipe; and No. 4, for ¾, 1, 1¼, 1½ and 2 in. pipe. Centering tool and extension are also available.—R. M. Starbuck & Sons, Inc., Hartford, Conn.

Weather Compensating Heating Control

No. 390—"Spence Weather Compensator" system orifices every radiator in a building in such manner that at 3 lb pressure, radiators will be completely filled with steam corresponding to 0 F outdoor temperature and a 50 mph wind velocity. No radiator traps are required as the orifices do not permit the passage of steam into the return line. The system is operated without a vacuum pump, the return risers being vented to the atmosphere.

Steam pressure on the system is regulated by means of a standard pressure regulator with a sensitive pilot valve which limits the variation in delivery pressure to within ½ oz, plus or minus. A "Modutrol" motor with a special cam is used to load the lever arm of the pilot to vary the steam pressure with the weather demand, the contour of the cam being designed to load the lever to produce the proper flow of steam into the radiators for any weather conditions. In the case of electrical trouble, power shut-off, etc., the motor will remain in the position last set.

This system utilizes dual control. The "Signatrol" is essentially an outdoor temperature recorder, so equipped that a change in temperature of over 2½ F plus or minus gives visual and audible signal so that an attendant may turn the knob and reset the steam pressure. A red or green light indicates the direction in which the knob must be turned and it is turned simply until the light flashes out and the signal stops. An anemometer automatically reduces the steam pressure when the wind velocity goes down and vice versa.

A control panel and time switch are provided. On the panel, the steam may be turned on or off, the steam pressure may be increased or decreased over the normal weather demands or the entire system may be thrown on to manual control. The time switch serves to increase the steam pressure for fifteen minutes every two hours to purge the system of water pockets, etc. The system may be applied to any number of heating zones.—Spence Engrg. Co., Inc., 110 E. 42nd St., New York, N. Y.

Thermostatic Mixing Valve

No. 391. Function of the "Babbin" thermostatic mixing valve is to deliver hot water for process or domestic use at a constant, controlled temperature from copper coils or tubes submerged in boilers. Hot water from the boiler coil or tubes enters one side of the valve and cold water the other. Quick acting thermostat in mixing chamber tempers the water to desired temperature.

Valve body is bronze casting to which is attached the temperature adjustment; the thermostat, of the solid filled liquid expanding type, is made of brass and copper.

Hot water can be delivered through this valve at any temperature between 140 to 190 F; changes in delivered temperature are made by a simple turn of the adjustment screw.—Evry-Use Products Co., Inc., 258-260 Canal St., New York, N. Y.

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● There is nothing more modern than Aerofin Standardized Light-Weight Fan System Heat Exchange Surface.

For either Cooling or Heating applications, Aerofin is the choice of important architects, engineers and contractors because it gives complete satisfaction and unvarying performance.

Aerofin begins where ordinary surface leaves off. Its exclusive features in design and construction make it the most advanced surface available today. It is furnished in aluminum, copper or other special metals.

The home office in Newark or any branch office will gladly send descriptive literature or render prompt, personal and efficient technical cooperation. Simply write to the address below.

Aerofin Flexitube Unit for Heating or Cooling with water.

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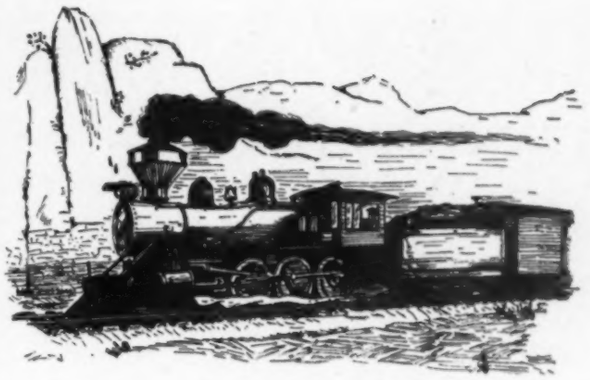

Casey Jones was not Afraid to Turn on Steam!

ARE YOU?

AS the old song says, Casey turned on too much steam and Casey and the whole works was a total loss. Your steam is not a total loss—but if you are distributing it *underground* without adequate protection for the lines, it's at least a *partial* loss. Don't you ever wonder, when you shoot steam through those lines, how much of it *gets there?* Protect your present or future underground power or heating lines with RIC-WIL.

RIC-WIL Conduit is the correctly engineered system for the permanent protection of underground Steam Lines. In combination with RIC-WIL DRY-PAC Asbestos Insulation, it is certified for the highest known operating efficiency. It is made in a variety of types and materials to meet all conditions. RIC-WIL Systems are complete, including installation instructions and engineering service drawings, also supervision for the job if desired. Bulletin 3503 on request.

The RIC-WIL Co., 1562 Union Trust Bldg., Cleveland, Ohio
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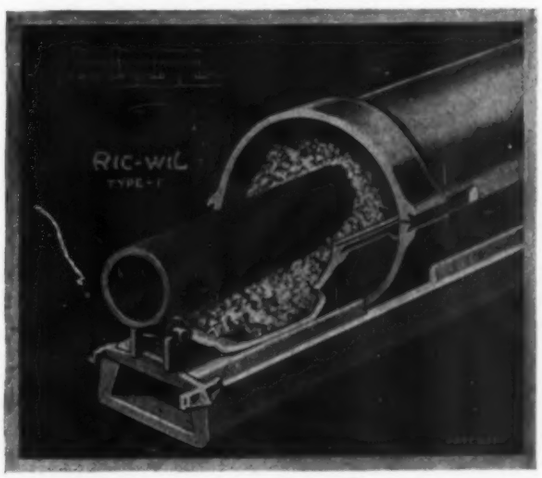
● RIC-WIL DRY-PAC is pure asbestos insulation, which has certified conductivity of only .36 B.T.U. for low pressure.



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BRASS FITTINGS

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FITTINGS made of finest quality red brass (high copper content) for life-long service and proof against corrosion.

FRETZ NIPPLES supplied in yellow brass, red brass and pure copper.

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Book Reviews

New Edition of Arc Welding Handbook

"Procedure Handbook of Arc Welding Design and Practice," published by The Lincoln Electric Co., Cleveland, Ohio.. 586 pp., 5¾x9 in., flexible binding. Price, $1.50; foreign postage, 50c additional.

The present volume is some 140 pages larger than the preceding one. New features added to the book include *American Welding Society* specifications for filler metal; method of determining the amount of current carried by the electrode; procedures, speeds and costs for making of welds in sheet metal; *A. S. M. E.* boiler code requirements for butt welds in heavy plate; hard facing of ferrous metals; examples of redesigning for arc welding; use of arc welding in making and repairing cutting tools and dies; speed of welding oil and gas pipe lines, etc.

Written especially for the use of designers, engineers, welding supervisors and operators, this handbook serves as a practical guide to those interested in arc welding and a handy reference for estimating welding costs.

The eight sections into which the book is divided cover the following subjects:

Welding methods and equipment; technique of welding; procedures, speeds and costs for welding mild steel; structure and properties of weld metals; weldability of metals; designing for arc welded steel construction of machinery; designing for arc welded structures; and typical applications of arc welding in manufacturing, construction and maintenance. Included in this last section is information on furnaces and heating boilers, gas plant equipment, general maintenance and repairs, piping, pipe lines, and sheet metal work, as well as a number of other subjects.

An advertising section is appended.

N. F. P. A. Proceedings

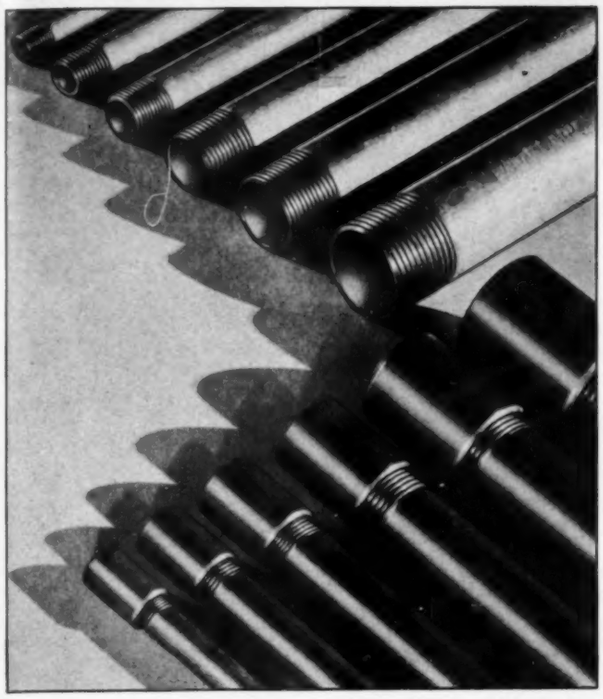
"Quarterly of the National Fire Protection Association—Proceedings of the 39th Annual Meeting," published by the N. F. P. A., 60 Batterymarch St., Boston, Mass.

This 514 page volume records the proceedings of the annual meeting of the Association held earlier this year at Atlanta, Ga., and includes the reports presented, whether or not adopted by the Association, and the discussions following committee reports.

There are a number of reports and papers of interest in connection with heating, piping and air conditioning, including reports on tanks; hydrants, valves, and pipe fittings; sprinkler piping; static electricity, dust explosion hazards; protection of records; blower and exhaust systems; and others. A paper by E. W. Fowler on fire hazards in ventilating and air conditioning systems is included.

One of last April's dust storms

AN EXCLUSIVE PROCESS



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The Fretz-Moon "continuous process" differs radically from other methods of pipe manufacture. And, likewise, Fretz-Moon Pipe differs from ordinary steel pipe, because it is better.

Made of highest quality steel skelp that is heated throughout every foot at unvarying temperature, for a definite period of time, without contamination from furnace bottom, and then roll-welded, sized, cut and cooled under precision control, this modern steel pipe possesses high degrees of uniformity, ductility and cleanliness not found in steel pipe made by ordinary methods.

If you would like to read the detailed story of the Fretz-Moon "continuous process," write for it.

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FRETZ-MOON PIPE
BLACK AND GALVANIZED

Over 3000 BINKS Cooling Systems • Now in use! •

BINKS ATMOSPHERIC SPRAY COOLING TOWERS are built in sizes ranging from 6 tons up to 200 tons refrigeration capacity, and are extensively used today in the ever growing air conditioning field.

BINKS INDOOR FORCED DRAFT Cooling Towers are also made up to 40 tons refrigeration capacity and are unexcelled for the smaller tonnage requirements where piping difficulties are encountered and piping cost must be minimized.

We offer a standardized complete SHOP CONSTRUCTED TOWER (with full spray nozzle distribution) for most every application. This is evidenced by the more than 3,000 Binks Cooling Towers now in operation.

The Binks line is recognized as being the most complete and includes spray and atomizing nozzles of advanced design for practically every industrial requirement.

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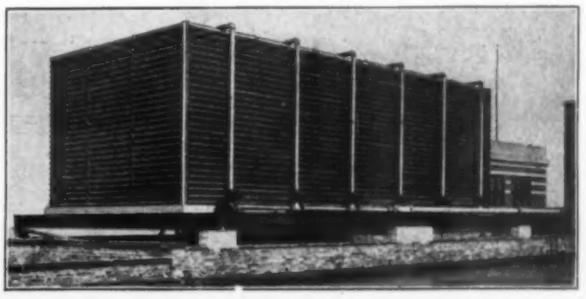

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Booklets, Reports and Papers

Data on Air Conditioning Installations

"Air Conditioning, 1935," *published by the Edison Electric Institute,* 420 *Lexington Ave., New York, N. Y.* 24 *pp.,* 8½x11½ in. *Price:* 50c *to members and their employees,* $1.25 *to non-members in U. S. A.,* $1.35 *to foreign countries.*

This report was prepared by the air conditioning subcommittee of the sales committee of the Institute, of which C. E. Michel is chairman. It consists of specific data on typical air conditioning installations in banks, hotels, offices, office buildings, printing plants, residences, restaurants, stores, and undertaking establishments in various sections of the country. Size and character of the equipment is described in each case as well as the purpose to be achieved, and information is given on hours of operation, maximum demand, energy consumption, and other related data.

Statements from a number of equipment manufacturers on the promotion of air conditioning by public utilities are included.

Standard for Refrigerating Systems

"Standard for Commercial Refrigerating Systems, Subject No. 207," *published by the Underwriters' Laboratories,* 207 *E. Ohio St., Chicago, Ill. Mimeographed,* 11 *pp.,* 8½x11 *in.*

This standard, dated June 17, 1935, supersedes the standard for commercial refrigerating systems of August 16, 1933. It covers classes C, D, and E systems (20-100, 6 to 20 and less than 6 lb of refrigerant respectively). Changes for the standards for refrigerants, motor controls and copper tubing are incorporated.

A new paragraph in the refrigerant sections reads:—

"Refrigerants used in air conditioning systems employing direct method of refrigeration shall be practically nonflammable and shall be of a *lower degree of toxicity* than group 4 as defined on page 106 under 'summary' of Underwriters' Laboratories' Report MH2375, entitled 'The Comparative Life, Fire, and Explosion Hazards of Common Refrigerants.'"

(Note: Group 4 is defined by Report MH2375 as follows: "Gases or vapors which in concentration of the order of 2 to 2½ per cent for durations of exposure of the order of two hours are lethal or produce serious injury: dichlorethylene, methyl chloride, and ethyl bromide." Refrigerants in groups classified as being less toxic than group 4 are butane, carbon dioxide, ethane, "Freon," F-11, F-114, and propane.)

In the section on motor protection which states that protective devices such as controllers incorporating thermal relays may have a heating element with a current rating of 140 per cent of the full load rated current, a new paragraph states:

"Fuses employing the usual type of cutout base are not recognized as suitable motor-running protection. Special designs shall be subjected to test to determine their suitability."

In the valves and tubing section, the standard for copper tubing has been elaborated. Wall thickness specifications for hard copper pipe have been added.

Manufacturers in testing pressure containing parts of the system must subject them to somewhat higher pressures than were required in the earlier standard.

Draft Hood Performance Studied

"A Study of Draft Hood Performance," by L. C. Price, Research Associate Professor of Mechanical Engineering, University of Arkansas. Published as Bulletin No. 13 *of the Engineering Experiment Station, Fayetteville, Ark.* 32 *pp.,* 6x9 *in. Price,* 15c.

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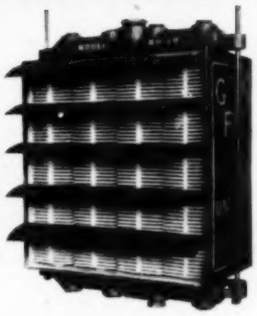

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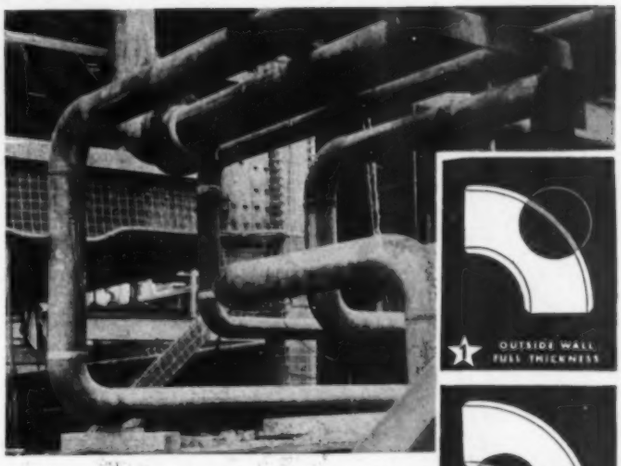

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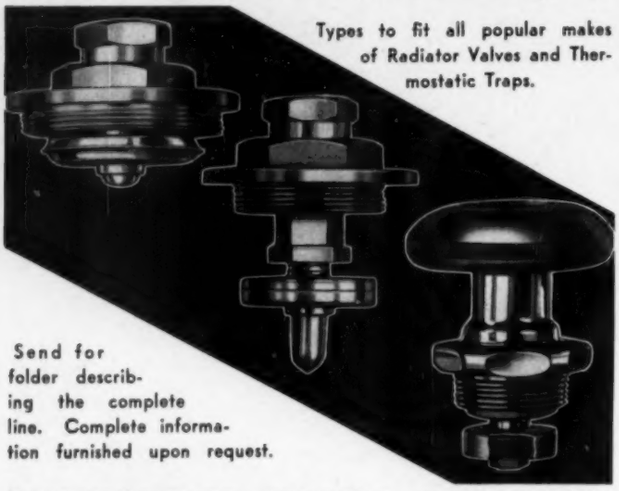

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After describing the tests and presenting diagrams and tables, the author concludes that the results indicate that it is entirely possible to design draft hoods which will, within the limits of experimental error, fulfill the ideal requirements. The best-performing hoods have certain characteristics in common, it is stated. They provide ample room for the passage of combustion products both up the chimney and to the atmosphere; the chimney opening being above, the combustion products prefer that way to exit. They all provide that air drawn from the surrounding atmosphere by up-drafts shall pass in a slow and orderly fashion by the inlet openings of the hoods, so that only negligible venturi effect is produced. They all have baffles of ample size so as to prevent down-drafts from impinging on the inlet opening and so opposing the entrance of the combustion products. All have ample room for down currents to pass to atmosphere without building up pressure in the hoods.

Conventions and Expositions

Midwest Power Show: October 14-18, Chicago, Ill. G. E. Pfisterer, Managing Director, 1 N. LaSalle St., Chicago, Ill.

American Gas Association: Annual convention, October 14-17, Palmer House Hotel, Chicago, Ill.

American Public Health Association: Annual meeting, Oct. 7-10, Milwaukee, Wis. Headquarters Office, 50 W. 50th St., New York, N. Y.

International Acetylene Association: Annual convention, Nov. 12-15, Cleveland Hotel, Cleveland, Ohio. Secretary, H. F. Reinhard, 30 E. 42nd St., New York, N. Y.

International Heating & Ventilating Exposition: January 27-31, International Amphitheater, Chicago, Ill. Manager, Charles F. Roth, Grand Central Palace, New York, N. Y.

American Society of Heating and Ventilating Engineers: Annual meeting, January 27-31, Palmer House Hotel, Chicago, Ill. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

National Warm Air Heating and Air Conditioning Association: Winter meeting, January 27-29, Hotel Stevens, Chicago, Ill. Managing Director, A. W. Williams, A. I. U. Bldg., Columbus, Ohio.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 103.

No. 571. AIR CONDITIONING: York Ice Machinery Corp., York, Pa. Data sheet illustrating stores in which this company's air conditioning equipment is installed.

No. 572. BOILER PLANT EQUIPMENT: Combustion Engrg. Co., Inc., 200 Madison Ave., New York, N. Y. 4 p. bulletin describing in condensed form boilers, complete steam generating units, stokers, pulverized fuel systems, and heat recovery equipment.

No. 573. CORROSION CONTROL: D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill. Issue of house organ including article on corrosion control in brine systems.

No. 574. COUPLINGS: S. R. Dresser Mfg. Co., Fisher

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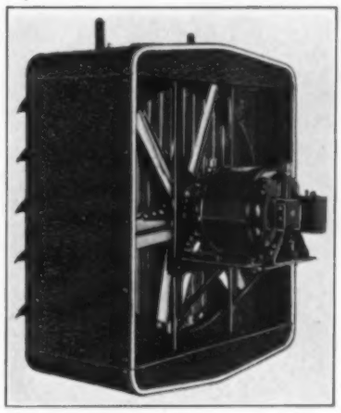

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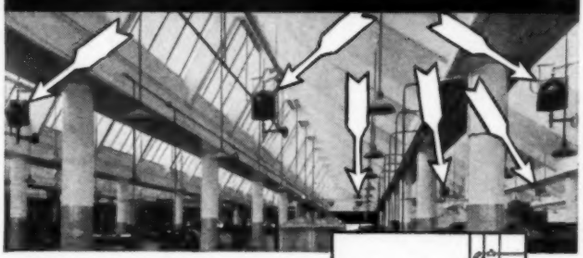

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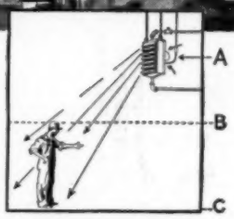

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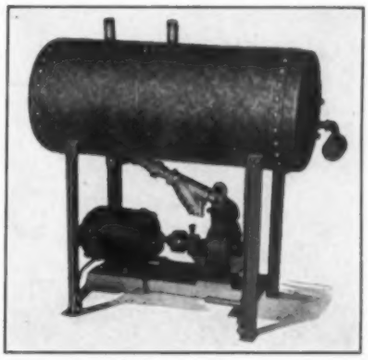

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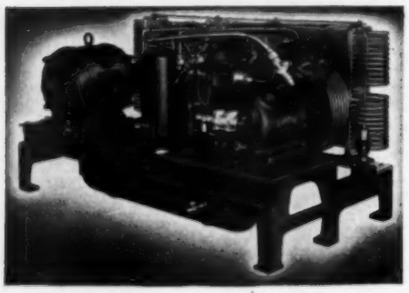

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Ave., Bradford, Pa. 16 p. booklet on pipe joints for water lines, including installation pictures and general information on pipe line products.

No. 575. ELECTRIC TOOLS: Independent Pneumatic Tool Co., Chicago, Ill. Catalog illustrating and giving specifications for entire line of "Thor" universal electric tools, including portable drills, screw drivers, hand grinders, bench grinders, nut setters, tappers, saws, and hammers.

No. 576. FITTINGS: Streamline Pipe and Fittings Co., Port Huron, Mich. Folder describing features and types of forged brass and wrought copper "Streamline" fittings for air conditioning and mechanical refrigeration systems.

No. 577. FLEXIBLE COUPLINGS: Morse Chain Co., Ithaca, N. Y. 24 p. bulletin on flexible couplings with full page charts for selection, dimensions, list prices, and detailed descriptions of the features of various types.

No. 578. FLEXIBLE COUPLINGS: John Waldron Corp., New Brunswick, N. J. 12 p. catalog of "Francke" flexible couplings including complete tables of sizes for the various types, directions for selection, and describing changes in design and materials.

No. 579. INSULATION: Insulite Co., Builders Exchange Bldg., Minneapolis, Minn. Folder on tile and plank for insulation, sound deadening, and decoration.

No. 580. INSULATION: Johns-Manville, 22 E. 40th St., New York, N. Y. 48 p. booklet of industrial products, including insulation, packings, refractories, roofing and siding, flooring, friction materials, electrical materials and "Transite" pipe, with complete information on uses, features, and recommendations for specific industries.

No. 581. PIPE AND FITTINGS: Continental-Diamond Fibre Co., Newark, Delaware. 46 p. booklet on "Dilecto," a laminated phenolic material, describing its properties, manufacture, and uses, among which are pipe and fittings for various process applications. Numerous tables are included.

No. 582. REGISTERS AND GRILLES: Register and Grille Mfg. Co., Inc., 70 Berry St., Brooklyn, N. Y. 24 p. catalog of cast and stamped registers and grilles of various types, grille specialties and setting frames, with complete information on features, sizes, specifications and list prices.

No. 583. SOUND CONTROL: Johns-Manville, 22 E. 40th St., New York, N. Y. 14 p. brochure on sound control of mechanical equipment, including air conditioning systems, oil burners, etc. Special treatment is given the subject of vibration isolation platforms for fans and motors.

No. 584. STARTERS: Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio. Data sheets on across-the-line type motor starters with description of features and construction.

No. 585. STEAM ACCUMULATORS: Foster Wheeler Corp., 165 Broadway, New York, N. Y. 8 p. technical bulletin on steam storage in "Ruths" accumulators for absorbing peaks and valleys of process steam demand to create steady boiler load. Arrangement is shown and actual flow charts are presented.

No. 586. SYNTHETICS: B. F. Goodrich Co., Mechanical Division, Akron, Ohio. 12 p. booklet on "Koroseal," a new synthetic rubber-like material showing properties, listing the various forms in which it is available, and describing uses, which include applications as gaskets and sealing members, laboratory tubing and others.

No. 587. TEMPERATURE REGULATORS: Fulton Sylphon Co., 19 Rector St., New York, N. Y. Loose-leaf bulletin on temperature regulators for liquids describing construction, operation, range, and adjustment of many types for various applications and giving dimensions and prices; 14 p. section shows typical installations of regulators, including heating, textile industry, chemical processes, food, packing house, and sugar industries, with a chart for calculating proper regulator size.

No. 588. THERMOMETALS: H. A. Wilson Co., Newark, N. J. 32 p. loose-leaf reference booklet on thermostatic bi-metals reviewing specifications, properties and methods of application, with 10 full page charts of deflection and force characteristics, and design formulas.

No. 589. TIME SWITCHES: General Electric Co., Schenectady, N. Y. 8 p. bulletin on general purpose automatic time switches describing construction and features and showing dimensions and connections.

No. 590. TRANSMISSION APPLIANCES: SKF Industries, Inc., Front St. and Erie Ave., Philadelphia, Pa. 32 p. catalog of ball and roller bearing transmission appliances, with list price supplement, showing load ratings and mounting diagrams for ball and roller bearing pillow blocks, flanged housings, take-up boxes, post and drop hangers, floor stands, replace boxes, lock nuts and washers; a 7 p. discussion of bearing problems, aids to selection, and dimensional and load data is incorporated.

No. 591: TRAPS: Yarnall-Waring Co., 102 E. Mermaid Lane, Chestnut Hill, Philadelphia, Pa. Circular describing new "Impulse" steam trap describing features and construction and diagramming a number of typical installations.

No. 592. UNIT HEATERS: B. F. Sturtevant Co., Damon St., Hyde Park, Boston, Mass. 20 p. booklet giving complete information on "Speed Heaters" including description of construction, capacity and dimension, tables, wiring diagrams, motor data, coefficients and example for calculating heat losses, and installation details.

No. 593. UNIT VENTILATORS: B. F. Sturtevant Co., Damon St., Hyde Park, Boston, Mass. 20 p. booklet on unit ventilators, with general information on school building ventilation, description of the units, temperature regulation, layout hints, standard arrangements and sizes, and typical specifications.

No. 594. VALVES: Chapman Valve Mfg. Co., Indian Orchard, Mass. 88 p. catalog of cast and forged steel valves and fittings for high pressure, high temperature service and for sub-zero operating conditions (pressures up to 1500 lb, temperatures from —100 F to 1000 F). Information is given on bolt steel; bypasses; chemical and physical properties; creep values; dimension charts for angle, check, gate and globe valves, fittings and facings; drilling templates and flange facing diagrams; flanged fittings; motor units; pressure and temperature recommendations; and specifications and design.

No. 595. VALVES: Consolidated Ashcroft Hancock Co., Inc., Hancock Valve Div., 11 Elias St., Bridgeport, Conn. 8 p. bulletin on new union bonnet bronze valve with stainless steel trim, describing construction features; also, 4 p. bulletin describing "Flocontrol" valve, manually operated with straight line flow characteristics. Sizes, dimensions, and flow charts are shown.

No. 596. WELDERS: Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio. Data sheets for engine driven arc welders, giving general specifications.

No. 597. WELDING: Hobart Brothers Co., Box HT95, Troy, Ohio. 40 p. booklet on "Simplified Arc Welding" outlining a few of the applications of electric arc welding in several industries and describing the equipment.

No. 598. WELDING ELECTRODES: Wilson Welder and Metals Co., Inc., P. O. Box 96, North Bergen, N. J. 32 p. catalog of welding electrodes, their metallic composition, physical properties, applications, and features, with information on welding procedure and tables of chemical analyses, voltages, recommended amperes for various diameters, sizes and weights, and amount of deposited metal.

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